SCIENTIFIC AMERICAN
No. SUPPLEMENT 185

Scientific American Supplement, Vol. VII., No. 185.
Scientific American, established 1845.

NEW YORK, JULY 19, 1879.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

PLANT AND ANIMAL LIFE.*

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II.

WE have seen in the last lecture † that the matter which is accompanied by the action of life is found first in a mass without particular shape, just as other substances are found in an uncrystallized condition. Cell formation then ensues by definite action between the atoms of this mass of protoplasm. Both this mass and the cells derived from it multiply by simple division, and grow as certain inorganic bodies grow by absorption or interstitial addition of the new matter.

These facts, which lie at the root of plant and animal life, deserve to be noted, not only for themselves, but for the reason that later on, in this course, when the formation of human society comes to be discussed, it will be shown to you that a resemblance exists between these phases of the matter of life and the different stages through which mankind passes in forming social relations. At first mankind is found to move in loose masses without definite ties to knit its individual members together, and give them corporate interests. At length the family is formed, which is analogous to the cell in the living matter, it being the unit of the subsequent structure of the body politic. In other words, there is a reproduction in the social world of the physical action which controls the formation of living bodies. We have seen that the cell, in organisms which consist of a single cell, multiplies by division, and we have seen that the egg of higher animals, such as the dog, develops by the same process. Our conclusion that all eggs are but specialized cells, and that a process of division of their contents lies at the root of the development of the embryo, is therefore true and must be accepted.

Let us take a step further in the development of animal forms standing higher than the protista, which we discussed in the last lecture. Passing over some intermediate forms of life, such as the flagellates, and the infusoria which reproduce with more or less complication the structure and actions of the monads, let us examine the development of the sponge.

After fecundation the egg undergoes self division, splitting into two, four, and finally a large number of cells and their multiples, until it assumes a common aspect of divi-

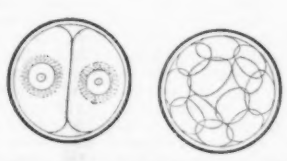


FIG 1.—SEGMENTATION OF THE EGG OF A SPONGE.

sion, which is called, from its resemblance to that form of fruit, the "mulberry stage." A mulberry, as we know, consists of a large number of little bags of liquid around a common center. The cells in the mulberry stage of the sponge become divided into two kinds; a few remain round, but the most of them become long and prismatic, and are provided with a thread which reminds us of the appendage to the cell in its free stage in the monads we discussed in our last lecture. It now leaves the egg and swims about in the water, aided in its progress by the thread-like filaments. Afterwards, by an infolding process, an internal cavity or stomach, bounded by the round cells, is developed in its inside.

This stage is called by Haeckel the gastrula stage, and deserves our close attention. For we shall find in the de-

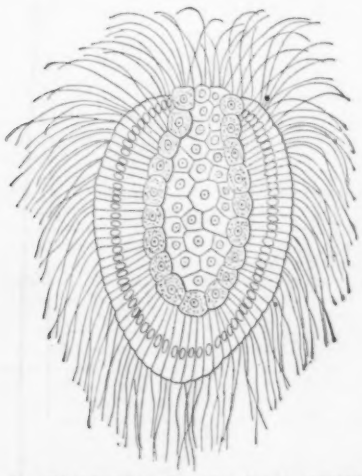


FIG. 2.—GASTRULA STAGE OF A SPONGE.

velopment of animals above the sponge that this gastrula stage appears more or less evidently in every one. This recurrence of the same form means that all animals pass through a gastrula stage. If all animals above the sponge were not really connected in time by blood, this common stage would not be recalled by them at one time in their existence. And the direct proof that they are so related is afforded by the recurrence of this stage. Below the sponges we have only the mulberry stage of the egg, or a number of self-divisions repeated in the cells, or egg-cells, of all animals. Above the sponge we have the mulberry stage of the egg, the planula or pregastrula, and the gastrula stage of the embryo following one after another.

It is easy to see in the gastrula stage of the sponge that the organism is made up of an outer layer of monad cells, and an inner layer of simpler cells, which retain their spherical form.

From this moment a division into two kinds of cells is commenced, which is carried on in higher forms of cell-life. After swimming about in the water for some time the young sponge becomes fixed by the end of its body to some object, the internal cavity remaining open at the top, and forming what we may call its mouth. You will see in its first being movable, and then immovable, a resemblance is offered to the lower plants, such as the algæ and fungi, which we discussed in my last lecture. The external threads now disappear from the outside and appear in the cavity. The outside wall of cells becomes full of openings into the main cavity. By the movement of these threads the water is induced to flow into the general cavity, and flow out through the open top. In its subsequent development the sponge becomes a hollow cylinder, built up by silicisus matter secreted from the water, and lined with cells which manifest a high degree of individuality. The cells have gone partly into partnership. But virtually it does not rise higher than the gastrula stage.

The food is absorbed by the cells of the inner lining. The different openings in the general structure are capable of being closed. Specialized cells, which either become eggs or male elements, are scattered up and down the structure. What we have seen in the sponge is the first appearance of a true stomach in animal life.

Above the sponges we will take up our cell development as it appears in the great class of worms. Haeckel divides worms into two classes, one of which possesses no blood, or true body cavity, the other a genuine body cavity, and a system connected with it which is filled with blood. As an example of the first class I will take the tape worm, and give you a few facts connected with its development, which may, perhaps, amuse as well as instruct you. This animal absorbs its nutriment through the body walls. The mulberry stage of its egg, and the gastrula (planula) stage of its embryo are passed in the egg stage. Its eggs are swallowed by pigs in human excrement. In the body of the pig its first developments take place. The head, which has four suckers and a central circle of hooks, is developed, and in this immature stage of the free embryo it passes into the liver or flesh of the pig.

In eating raw or badly cooked pork these minute embryos are transferred to the stomach of man. New joints then arise behind the head, until at last the animal may reach a total length of between ten and twelve feet, with from 800 to 1,000 joints. Each of these lower joints develops specialized eggs or cells, and then break off. These packages of eggs are voided from the human system, to be again eaten by hogs with the same result as before.

In so far we have followed the development of an animal which is interesting in an economic point of view, but which has not brought us much further in the development of cell complexity. But here we must note the fact that although the tape worm appears as a connected series of rings it is not one animal, strictly speaking, because its several rings discharge all the efficient life actions. Each ring is still analogous to a simple cell. It is comparable to the sea-weeds which we discussed, which stand higher than the single-celled bryopsis, and whose body consists of a succession of spore-bearing cells. In the higher plants, as in the higher animals, the division of labor is carried out to a greater extent than in the sea weeds and the tape-worm. Some cells produce young exclusively, others go to build up the different parts of the plant or animal.

We will now take one of the higher worms, one in which the internal cavity is filled with a vascular system admitting of an internal circulation.

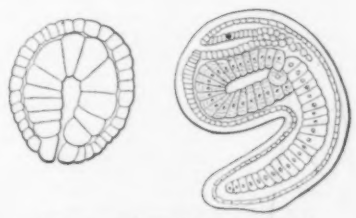


FIG. 3.—EMBRYO ASCIDIAN.

Such a worm lives in the sea, and belongs to a class called tunicates, from their harder outside covering. The eggs of this ascidian develop by division, and pass into the mulberry stage. After this the cells form a true gastrula, which is exactly like that of the sponge, only in the sponge the gastrula was free, and the outside layer of cells was provided with threads. But here the development does not stop.

The opening of the primitive digestive cavity closes and a body cavity is developed between the outer layer of cells and the inner layer. After this another cavity is formed by a union of two ridges which grow out from the outer layer of cells. This latter is the development of the nervous system, and in this cavity are subsequently developed the sense or-

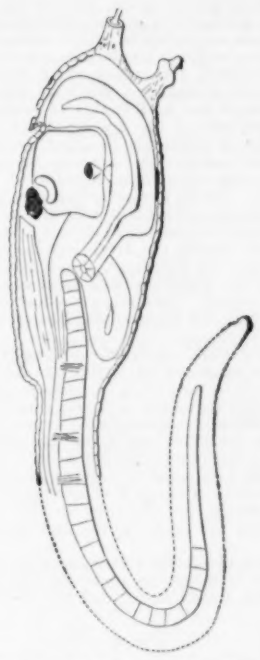


FIG. 4.—LARVAL ASCIDIAN.

gans. We now for the first time have an animal which exhibits the essential form of the higher vertebrate animals. The nervous system is situated above the digestive cavity, and by a prolongation of the cells which form the inner layer, a tail is formed, which answers to the vertebral column in the higher animals.

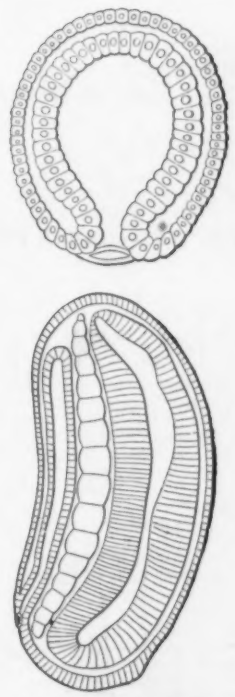


FIG. 5.—EMBRYO AMPHIOXUS.

Next in order come vertebrate animals which have no skull, such as amphioxus and the lamprey. They have no true backbone, but a dorsal cord, no or little brain, no true heart, and with the front end of the alimentary canal perforated with gill slits like those of the mature ascidian. These skulless animals are the lowest type of backbone animals.

The amphioxus is much like a worm in appearance, but undoubtedly is a low type of backbone or vertebrate animals. Its structure is less complex than that of insects. It lives in the mud or sand in shallow sea water. It has no hard skeleton and seems destitute of sense organs.

* A lecture delivered in the Popular Scientific Course, before the Buffalo society of Natural Sciences, Feb. 8, 1879.

† Scientific American Supplement, No. 179.

We may pass from these to the lower fishes which have soft backbones to the higher ones which have hard bones. From the fishes we easily ascend to the reptiles, from the reptiles to the birds, and from the birds to the mammals. All the modes of development found in the higher vertebrates are to be looked upon as modifications of those which we find in amphioxus.

The skull is made up of certain bony pieces which are specializations of the anterior end of the backbone. When we seek the origin of the nervous system we have to go back to the amœba, where every portion of the animal is capable of movement. Through the contained mass little waves make their way upon the shock of contact. In these we may see the channels of future nerves. With the advance in grade a less changeable body characterizes the animal, and certain parts of the body are more exposed to the action of the outer world, and will become more sensitive. Such portions under continual stimulus become the seat of more rapid and particular atomic changes and lead to the formation of nervous tissue. This view of the origin of nerves, due to Mr. Spencer, seems to gain strength from the facts we are discovering with regard to the nervous system of low organizations.

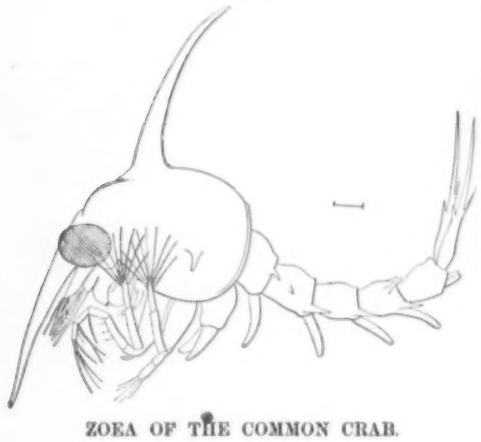
It seems to me that Shakespeare is mistaken when he compares the sufferings of a worm to those of a giant. Man is the great sufferer in this world. The nervous system and brain being less developed in animals, they must suffer less, and many of them can hardly be held to suffer at all. Probably some plants suffer as much as some animals.

We have gone briefly over, as indeed we were obliged, to the development of animal life. We have seen that in its highest expression it is a modification of original cell life. The bony or hard parts of the lower animals are secreted from the elements in which they live, and are mostly exterior. In the bony animals, they are secreted on the inside, and the matter composing them is absorbed through the digestive system. Let us now return on our path and show that certain stages of animals now existing were produced as the perfect form of animals now extinct. In the common king crab of our coasts, the larva has the body divided into two portions. In this stage, it resembles a trilobite. The division of the body into two parts and the general form is closely copied. Trilobites are among our oldest fossils. We may find also innumerable instances of such resemblances.

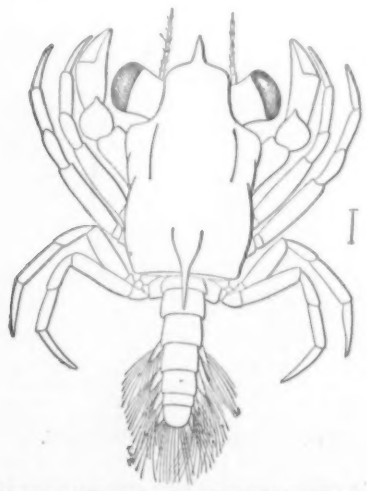
In determining relative rank among a group of animals, we must be also influenced by the different forms assumed by species in their development. In insects, the mulberry and gastrular stage are passed in the egg, and afterwards a true worm condition is assumed in the larva. This larva is not immediately developed into a true insect consisting of three body parts, but passes through a condition in which the body is divided into two parts, in which it resembles the crabs. We have thus a key to a classification of the order of winged animals, furnished by the life history of a single individual belonging to the highest group in that order.

Again, we have a key to the succession of animals furnished by a member of its group. In the crustacea, the body consists of two parts, a head-thorax, and an abdomen. In crabs

FIG. 6.



ZOEA OF THE COMMON CRAB.



MEGALOPS OF THE COMMON CRAB.

the abdomen is very short, and in lobsters it is long. Now the common crab in its immature stage resembles the lobster. It has a longer abdomen; it therefore passes through a stage in which it resembles the lobster, and discards that stage.

We must, therefore, conclude that lobsters are lower than crabs in the rank of life. In a fossil state we find lobster-like crustacea below those which more resemble crabs.

Again, in the development of the toad, it is at first without any limbs, and has external gills, and swims in the water. Afterwards the limbs bud out, and the tail of the tadpole stage gradually disappears. Now the tail and the gills are retained by our common necturus, or hell-bender of the lakes, so that we must consider that toads stand higher than the necturus. Again, the toad in the tadpole state resembles

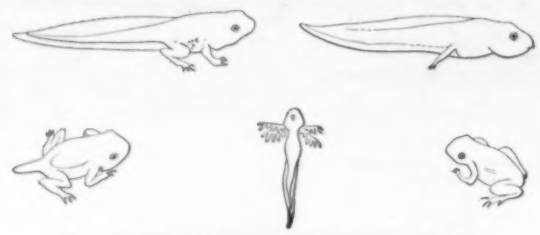
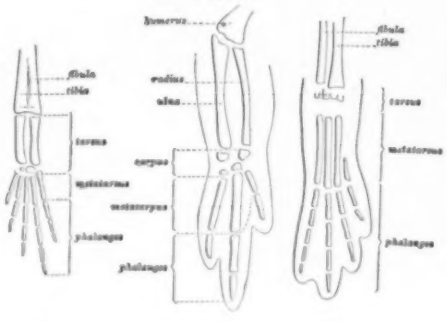


FIG. 7.—METAMORPHOSIS OF THE TOAD.

the lower fishes, and fishes preceded reptiles in the succession of life as we find from fossils. Let us now turn to the development of the limbs in the higher vertebrates. The legs of a bird are first seen in the embryo as a fin, in which

FIG. 8.



1. RIGHT LEG OF A YOUNG TOAD.
2. RIGHT WING OF AN EMBRYO BIRD.
3. RIGHT LEG OF AN EMBRYO BIRD.

they resemble the appendages of fishes. The bones composing the leg are seen to be gradually and separately formed. At this time it resembles the legs of reptiles, in which certain of the bones, called the metatarsal bones or hand bones, are separate through life. Afterwards the hand bones in the bird are joined together and become solid. At the same time the toes in the embryo land bird are webbed together, and the webs subsequently disappear.

We have in this a proof that the water birds are lower than the land birds, because the land birds pass through a stage in which they resemble the water birds before hatching. At the same time we can study the development of the legs. The bones of the wing are separate, and the wing in this stage looks like a foot. From this fact we can see that the wings and legs in birds answer to the fore and hind feet of reptiles and quadrupeds. The labors of my friend Prof. E. S. Morse have brought out all of these points in detail.

When we speak of the continuity of forms it is our duty to show that such a continuity existed in nature. We can do so by showing that birds gradually develop in time from reptiles. The flying reptiles came before the birds, as we find by the discovery of their remains in a fossil state. Nothing so easily separates existing reptiles from birds as the presence of teeth, and the difference between scales in reptiles and feathers in birds. Reptiles also have long tails and birds have short ones. Now in the slates of Solnhoffen, we have found the remains of a bird which represents an intermediate stage between the tail of a reptile and a bird. This bird had a long tail bordered by two rows of stiff feathers.

Prof. Morse has shown that if we telescoped this tail by driving it in, we would have a tail similar to that of our existing birds. As to the difference of teeth, Prof. Marsh has discovered in the tertiary formations of the West the remains of various forms of birds with teeth. The jaws and teeth of these birds show them to have been carnivorous and probably aquatic. They had powerful wings and were capable of prolonged flight. The teeth, in their form, resembled the teeth of reptiles. In each lower jaw there are twenty-one distinct sockets. The teeth in these sockets are small, compressed, and pointed, and are all directed more or less backward. The crowns are covered with nearly smooth enamel. The teeth seem to be about the same in both upper and lower jaws.

As to the difference between scales and feathers, it is more apparent than real. Both are modifications of the same layer of the skin. In their first rudiments they are completely identical, and a feather resembles a scale even more than it does a hair. In the tail of the beaver we have scales replacing hair, and in the wings of certain sea fowl we have scale-like feathers.

In a former lecture ("Man and his Structural Affinities") I have discussed the question of comparative hairiness of men and animals. The heart of the bird in its arrangements resembles the heart of the reptile, and the windpipe is not branched as it is in mammals. In some water fowl we find a persistent claw at the extremity of the wing like the claws of reptiles.

Among the reptiles there is a gradual transition to the leg of the bird, and the embryo bird resembles the mature reptile in the separation of the hand bones, as we have already pointed out.

The distinctions between the five great animal types of Cuvier and Agassiz are seen to become evanescent. The more fossils we find, the more clearly is the history of the gradual development of the present species made out. This illustrates what I said in my first lecture, that in proportion as we know allied objects, is our comprehension of already observed objects increased. We recognize parts of a thing when we see half of them before us in a different combination. We must compare the parts of one animal with the parts of another, and in this way find the differences and resemblances between the two. By a comparison of many allied objects, what at first seems a great difference is seen to become unimportant and fade away. When, as in the case of birds and reptiles, all the radical differences which we can perceive between the two classes are seen to fall away, we must rationally conclude that radical differences do not exist. The information we get from our discoveries of fossils on this point, must be added to the information we get from studying the development of existing reptiles and animals, to form a true conclusion in the premises.

We must conclude that the differences between birds and reptiles, as now found, have gradually come to be what they are, and at one time did not exist.

In studying groups like the snakes, we find characters

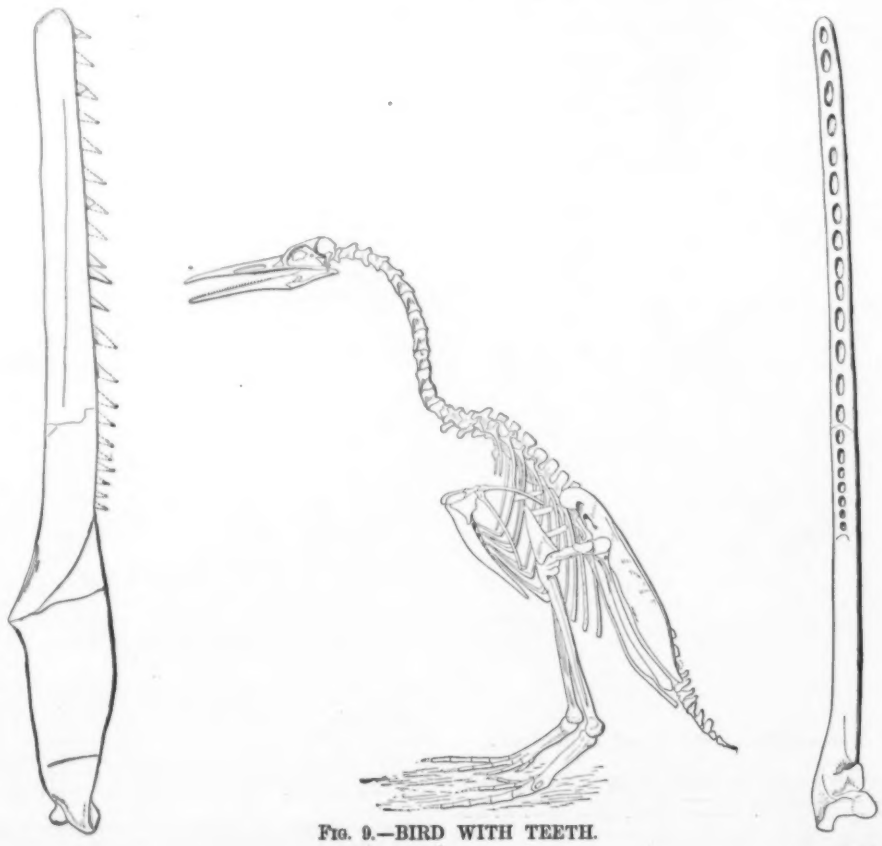


FIG. 9.—BIRD WITH TEETH.

which lead to a reasonable belief as to their origin. The snakes have in great probability developed from ancestors possessing limbs, because in several species we find rudiments of posterior limbs. Turning to the lizards, we find in those most like the snakes limb girdles taking the place of the legs. As the surroundings and habits of life changed, there is no more reason to avoid the inference that the legs may have become useless and gradually aborted, than to avoid the necessary conclusion that the aborted parts of organisms generally are aborted through disuse, their presence being no longer useful to the continuance of the species.

As to their habits, even now a number of reptiles are borne through the air by means of a web-like expansion on their feet. Many live in trees, while it is a curious fact that we have discovered that certain of the fossil flying reptiles inhabited holes in trees, where they deposited their eggs without any artificial nest, just as our lowest kinds of birds now do. The nests of birds have their own evolutionary history, from those which are merely places of deposit, to the elaborate structure of the bower bird. This bird is no longer satisfied with a simple shelter for its eggs, but erects a fanciful structure upon the ground, which it decorates and uses as a promenade, an audience chamber, and a hall for dancing!

But it is in the development of mammals through geological time that we are most interested.

Let us take the development of the brain We can easily show the change in form of the front limbs and the difference in the position of the backbone from the four-footed animals through the monkeys up to man. The brain is formed at the extremity of the backbone. It consists, in the lowest vertebrates, of five sacs. In amphioxus, the anterior end of the dorsal cord extends beyond the brain. We must, therefore, conclude that the subsequent skull is formed from joints of the backbone, which subsequently inclose it. We shall presently see in the embryology of man the resemblance between his brain and that of other animals.

At this point I wish to draw your attention to the progressive increase in the mass of the brain which we find in mammals from the tertiary up to the present time. In these fossils we find, as in dinoceras, that the bulk of the brain bore no proportion to the size of the skull. The small brain is reptile-like, while the body is as large as that of an elephant. There is found to be an evolution in the size of the brain from that time until this. The energy which was in the muscles of fossil animals became transferred more and more to their nervous center. They decreased in bulk and gained in intelligence. In man to-day, although a change in the development of the body has not entirely ceased, it is the mind that is most active and susceptible to change.

The evolution of the horse through a succession of animals with a different number of toes, showing how our modern type was gradually developed, has been admirably investigated by Prof. O. C. Marsh, and Prof. Huxley has fully discussed this matter in his New York lectures. The series of animals terminates in the hipparion, or three-toed horse, the precursor of our modern genus Equus. Now occasionally our one-toed horse becomes two-toed, and this is then called a "freak of nature." But it has a meaning. This freak is a reversion toward the hipparion type, a proof that horses had more toes once than they have now. Now heredity itself is only (*cf.* "Man and His Structural Affinities"*) close reversion.

In this view of the case, "monstrosities" are not to be considered as accidental or fortuitous, but to arise either from a special exciting agent (*i. e.*, the "accident"), or from a reversion to a former physical condition of the species. We must use our reason in these matters, and not merely view the "freaks of nature" as wonders or manifestations of hidden powers; we must study their origin, and find out what they mean, and when we do this, we find that they are important guides in the solution of the question of the origin of species. Nature is never meaningless, that is, she always shows an endless succession of antecedents and temporary results.

FIG. 11.

1. FOREFOOT OF HORSE (*Equus*).
2. FOREFOOT OF HORSE WITH EXTRA DIGIT.
3. FOREFOOT OF HIPPARION.

I remember hearing President Porter in an after dinner speech making fun of Professor Marsh's "horses," which could be contained, he thought, in a moderate sized box, as if the smallness of the collections had anything to do with their value. But the collections have probably increased since then, and tell the facts more plainly, and I much question if they are not now the most interesting of the Yale College collections in any department. There was a laugh among the diners on the occasion, but it seemed to me to be a kind of "horse laughter," which merely served to sustain the president and other gentlemen present in the belief that metaphysics were of more value than facts and the conclusions to be drawn from facts.

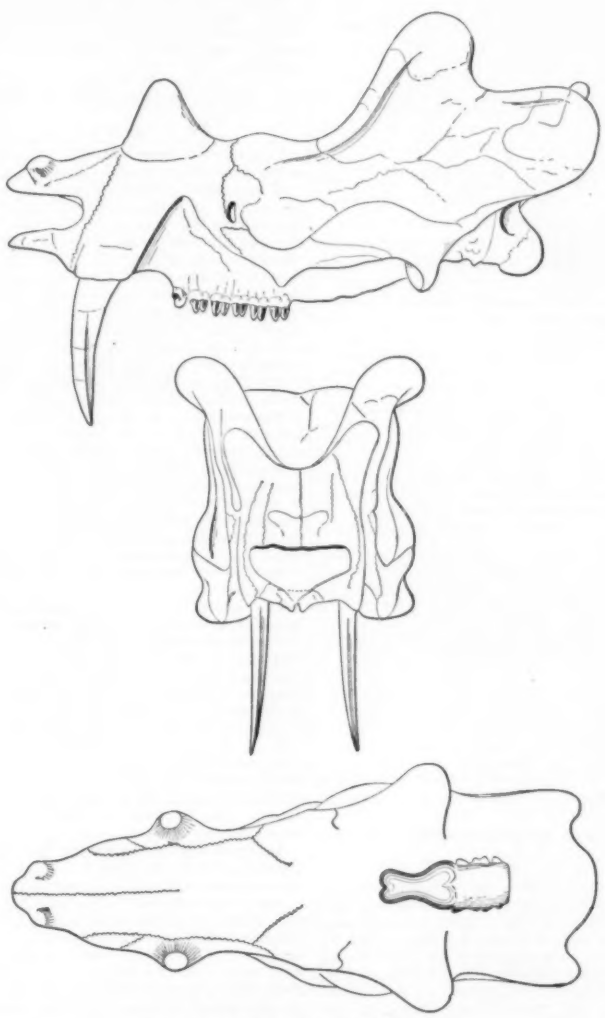


FIG. 10.—SKULL OF DINOCERAS.

Man in his embryology passes through changes in which he resembles all existing animals. At first, the human egg is a minute mass of protoplasm like a monad. In the earliest egg state he cannot be distinguished from a sponge, a worm, a fish, a bird, or other animal. The human egg increases by division, like all other eggs, and finally reaches the mulberry stage. It then passes through a stage in which it resembles the gastrula of the sponge. It then attains the worm stage. It next enters upon the amphioxus stage with neither brain nor skull, but having gill slits like the animals that breathe in water. It then passes through stages in which it successively resembles fishes, with brain and skull, reptiles, mammals, and, finally, the highest monkeys. It does not lose its monkey characteristics until some time after birth.

The pelvic girdle is contracted in the infant as in the apes. In its efforts to walk the girdle is opened out, the sutures being flexible, and in this way the shape is altered until it becomes like that of the adult man. The convolutions of the infant brain are like those of the adult chimpanzee.

It may be asked why man passes through all these stages. To this, science makes the answer that it is because man is connected by blood in time with all other organized beings. A proof that man is so connected is further evidenced by his possession of useless organs. The muscles which move the long ears of the horse and the donkey, the rabbit, and other mammals are present in man. By disuse they have become rudimental, and few persons can now move their ears. The tail external to the body is wanting in the higher apes, but man in his embryo possesses a tail, as do the lower monkeys.

In my first lecture I showed that there were conditions acting upon the egg which determine at what point the development shall stop. These conditions are the force inherited by the particles of the egg from the organism which threw it off, and the resistance of the forces around it, the egg being, in all cases (as we found), a single specialized cell of the parent. The movements of low organisms we find to be determined by their density and dynamic weight. Although their environment is much more complex, to the same cause we must ultimately ascribe the variation in form which we see among existing plants and animals. By experiment we can modify the environment of an animal, and we have found that this change is reflected in its growth. One of the most striking instances of such a change has been found in the water-salamanders of Mexico, and the lakes of the Rocky Mountain region. A lady, Frau Von Chauvin, found by experiment that these water-salamanders, which have external gills, on being gradually subjected to a change from a water to a land life lose their gills, and afterward breathe entirely through their lungs. Usually they breed in the water, and do not go further in their life change than the gill state. This change to a higher stage, before which the animal usually stops its growth, is accompanied by movements on the part of the animal which can only be interpreted as an involuntary effort to adapt itself to its new surroundings, and in which it sometimes succeeds. A sudden change is found to be fatal.

By gradually accustoming the axolotl, or Mexican water salamander, to life on land, the gills dried up and the water-breathing was transferred into an air-breathing animal, the lungs alone being used. The converse of this experiment was also tried, and the young of the air-breathing alpine salamander (*Salamandra atra*) developed a set of water-breathing gills on being placed in the new element. These experiments have since been repeated, and they are interesting because they show the way in which water-breathing reptiles may have passed into air-breathing reptiles under certain mechanical changes of condition. In one word, they supply the probable *modus operandi* by which a large class of amphibia were evolved from a pre-existing and lower class of similar organisms.

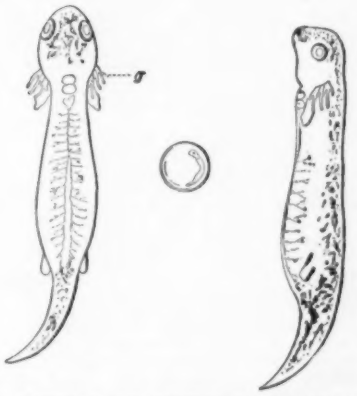


FIG. 12.—EMBRYO OF *SPERLERPES SALMONEUS.*

In illustration of the salamanders I give the egg and enlarged figures of the advanced embryo of *Sperlerpes Salmoneus*, a species found in small springs emptying into Niagara river. The process of budding of the gills, *g*, and the fore and hind extremities, has been observed by me in the aquaria of the Buffalo Society of Natural Sciences in May. The necturus of the lakes retains its gills during life, but they are dropped in the adult sperlerpes. The embryos observed, May 7 to 15, while yet in the transparent egg envelope, had the rudiments of the legs short and rounded; these became gradually pointed and longer: the gills on May 8 were provided with 3, 2, and 1 finger-like extensions to the three gill stems; on May 9, there were 3, 2, and 2 (as in figure); on May 13, 4, 3, and 3; on the 15th, 4, 4, and 3, continually elongating. These embryos were excellent subjects for the study of the circulation, being almost transparent. On the 8th the eyes were yet quite pale; from the following day the eyes became gradually darker, leaving a pale central dot. On the 16th, the toes were outlined on the extremity of the fore feet; the development of the hind feet was delayed about 48 hours behind the first pair.

Again, it has been shown by experiment that a change of temperature affects the shape of the wings and the colors of certain butterflies. The coloration and relative size and shape of birds and mammals are found to vary according to the latitude in which they live. Sunlight intensified by reflection is found to effect a whitening or blanching of color among birds and mammals, and even in fishes in the water.

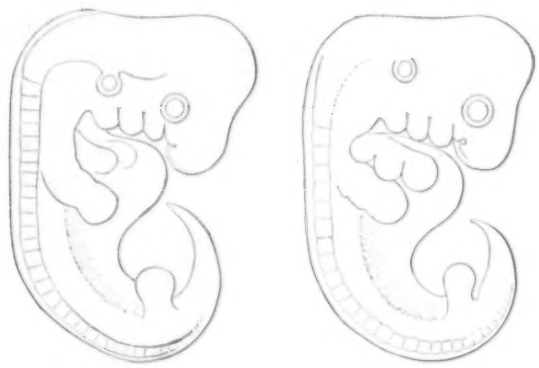
If all the light falling on an object is absorbed by it, the aspect is black. Most animals exposed to light possess color. Among animals possessed of darker colors the tendency to vary toward white is directly as the amount of reflection in their surroundings. This is the conclusion reached by Prof. Yarman from a wide knowledge of facts. The amount of variation which animals may undergo by a change in their environment cannot be discussed without considering our domestic animals. These have all originated from wild stock; in most cases their ancestry can be directly traced, although the popular opinion is even still that they were created in a state of domestication. In these lectures I have endeavored to direct your attention to the relation between animals and their surroundings. The efficient cause for variation, which has been proven by the researches of Mr. Darwin, I need not discuss here. Natural selection is one of the ways by which a direct change in the organism is proven to be effected. And it has been further shown that changes produced by this, or any other near cause in the total surroundings of an animal, are retained by the species

* Published in part in SCIENTIFIC AMERICAN SUPPLEMENT a. d *Popular Science Monthly.*

when its possession aids its growth and extension. The newly acquired energy received by the parent is transmitted to the specialized cell, which it throws off as an egg. At the bottom it is found that the movements of plants and animals are the real cause of a change in their form and constitution; and animals, moving more than plants, are found also to exhibit a greater range of variation in form. Behind their exterior changes lie the movements of the atoms of matter of which they are made up. All arrests of development, physical and mental, arise from a want of energy and unfriendly environment. We have arrived at the point where we set out in our first lecture, that movements depend ultimately upon the kind of particles of which the thing that moves is made up.

All variations are seen from their very *raison d'être* to originate with the individual and not with the species. Out of these variations "species" arise. There is then no such thing as a closed species in nature. Instead, we have a group of individuals which more or less resemble each other, and by the amount of their coincidence reveal the nearness of their kinship. Between such groups of individuals a general larger or smaller resemblance exists, and here equally denotes the length of time or the force of circumstances which has resulted in their present differences and separation from a common stock.

We may conceive the succession of life as a tree with many branches and branchlets. If we buried such a tree in the ground so that its upmost branchlets, in their natural position, only peeped a little way above the surface, we might infer while walking over the area covered by them, that these different little twigs were really different plants, and had no connection. They seem distinct and separate; but if we made a horizontal cut a little way down, many of these little twigs would be seen to run together. Others would appear still separate, because we had not yet got to their connection.



Dog (IV Weeks) Man (IV Weeks)

Dog (VI Weeks) Man (VIII Weeks)

FIG. 13.—EMBRYO OF DOG AND MAN IN DIFFERENT STAGES OF DEVELOPMENT.

Now let us conceive the top surface to be the present time, and the cut down a little way to be tertiary time, and we should be able to trace a type through the remains of a succession of individuals. In some instances we have proved the actual succession of forms. Certain kinds of shells can now be connected in cabinets, individual after individual, each varying a little in one direction or another until we come, without a break, to tertiary specimens, at one time held to be distinct "species." Cutting down again lower, while some of the longer branches would persist, others, with all their smaller ramifications, would be cut off entirely. And supposing this second cutting to represent secondary time, we find that this corresponds again to what we know of the development of life.

All the higher tertiary forms have been cut off. The branches which remain have not differentiated so high up, or are straight simple branches thrown off way down at the roots, as the sponges and corals which persist with little change throughout the series. Some branches would be found to converge, which were at the top wide apart. At the bottom we find this tree to have its roots in protoplasm, the lowest form of organic matter; and the difference between this protoplasm and inorganic substances is found to depend, not on its particular elements themselves, but in the method and quantity in combination. Both plants and animals originate from a common stock. That stock was protoplasm in the form of cells. A variation sprang up through a change in the environment, by which some cells became harder externally, and these single cells were the progenitors of plants through the algæ and seaweeds, as I have explained in my first lecture. With regard to the ancestry of any form of life it is not necessary to assume that it is a linear development from its nearest ally. Mankind is not directly descended from existing anthropoid apes, but the stem which culminated in man arose from the same stock which, in another direction, produced the chimpanzee.

Science answers the conundrum of whether the egg or the hen was first made by showing that they at last come together. The higher we rise in the scale of life the greater the divergence between the egg and the adult form. The lower we descend the nearer the approach. Below them both rests the amorphic matter of life, out of which all live things were made and without which organic life could not exist.

In the artificial varieties of animals produced by breeding, man avails himself of the existing laws of development and species making. He copies and assists nature, just as by altering a river course he makes the water to flow in a new direction. But the impulse to flow is there; and so, also, is the tendency to vary inherent in the animal form.

In astronomy, the nebular hypothesis, which is pure evolution, is the accepted basis for our understanding of the stars. Is it to be conceived that evolution can obtain in the universe beyond, and special creation on the earth? Do heavenly bodies move strictly in conformity with laws governing the motion of matter, and are these same laws to be violated here to produce such specializations of matter as plants and animals? As well might we say that while our own bodies grow according to certain well known laws of development, some one organ is exempt from the working of these and increases by miraculous power. Whatever our fate, we are of the universe and cannot leave it, if we would. We can do very much to render this earth pleasantly habitable, nothing to escape from living under its constitution.

You will remember that we know the composition of protoplasm, and that we are not yet able to make it out of its elements, but we have been able to make certain other organic compounds, such as urea. And on the other hand, we are not able to make certain inorganic substances, although we know their composition. There is nothing about protoplasm which is more mysterious than urea, of which we know the composition and can make it, or of the diamond, of which we know the composition but cannot make it.

We may conclude from our studies that organic matter is the result of the combination of inorganic matter, and also that protoplasm need not have anything more extraordinary about its origin than other combinations of matter which we do not think mysterious. The question of spontaneous generation is not the main question in the problem of life, because we find a succession of development as the matter now stands. The saying, that everything comes from pre-existing life (meaning organic life), need not have been true for the lowest form of such life, because it holds good for those above it, if they succeeded by a blood series. But everything depends on what we mean by "life." If our mass of protoplasm that moves about and absorbs new matter is alive, then life has many grades. That it has many phases we know from its embryonic development. There is less difference between the life which this lowest form of organized matter exhibits and the life of inorganic matter, than between it and the life we see displayed in adult vertebrate animals. In this way we may arrive at the conception that life is a form of the eternal movement of atoms which surrounds us, and of which we are a part. We can reduce all definite ways of motion at last to one way. Evolution of matter by one source of energy leads us to the purest philosophy and to the contemplation of one God.

It now remains for me to point out that the brain is the seat of a nervous center which has gradually developed in the vertebrate life. That so far as we can see instinct only differs from reason in the greater simplicity of its action and thus in degree and not in kind. The mind of animals and men is found to be built up out of impressions received in the nervous center of the brain through the nerves. Where there are no nerves there is no mind. Where, in the individual, the nerves are impaired, the mind suffers. The brain receives through eye and ear certain intelligences which it would not have without their aid. The brain materially absorbs these impressions, which become fixed and constitute memory. The new atoms which the brain receives seem to fit into the old moulds which the former impressions have made on the brain mass, and so our experiences are not forgotten. I have shown in my first lecture that we only understand the succession of events and that we know things by comparison merely. We cannot understand the thing in itself. We know how things repel, attract, and affect us. Our ideas spring from putting the single experiences of our senses together. We can revolve them back into single impressions and prove the fact. Knowledge depends on time, experience, and comparison. Our apparent freedom of will is not an absolute freedom, but depends itself on natural causes, the extent of our knowledge, the amount of our experience, our inherited capacities, the comparatively wide elbow room we have come into in the world. Our moralities, or rules of conduct, arise themselves from our environment. There is no absolute right, but what appears so is the result of former experience. It is the best sense of the world, not the common sense.

Morality is comparative throughout different peoples and different ages, and depends ultimately on knowledge. Its rudiments appear in the conduct of animals. When we knew no better than to teach "creation," we were not wrong in teaching it. Now that we do know better, it is a mistake of the intelligence to hold to the old opinion, and it becomes a wrong to teach our children the fairy tale of miraculous creation as true, since it is one from a belief in which they will suffer in their after life. It is, at least, giving them something they may have to lose, if they are to develop intellectually, and the loss of which will give them pain.

The Rev. Henry Martineau, of England, says: "The whole history of the genetic order of things religion must surrender to the sciences. In the domain of physical investigation theology is an intruder and must stand aside."

The object of science is to ascertain proximate truth by means of the senses. Science has discovered that there is a succession and connection throughout the universe. It demands that this truth be recognized and be taught to the young in schools. It shows that it will be to the good of the whole state that its members grow up with a recognition of the true condition of the affairs which surround them. But it especially insists at this time that to teach the fairy tale of creation, as we have called it, is to sow a confusion of ideas which, in the soil of our social life, adds to the crop of disorders and disagreements, preventing harmony in the body politic, and constantly endangering the safety of the Republic.

SUSPENDED ANIMATION.

By BENJAMIN WARD RICHARDSON.

LET me next point out what, by experiment, is known as to the possibility of suspending animal life.

If an animal perfectly free from disease be subjected to the action of some chemical agents or physical agencies which have the property of reducing to the extremest limit the motor forces of the body, the muscular irritability, and the nervous stimulus to muscular action, and if the suspension of the muscular irritability and of the nervous excitation be made at once and equally, the body even of a warm-blooded animal may be brought down to a condition so closely resembling death that the most careful examination may fail to detect any signs of life. I have shown in a Croonian lecture that there are three degrees of muscular irritability, to which I have given the names of active efficient, passive efficient, and negative. The first of these states is represented in the ordinary living muscle in which the heart is working at full tension, and all parts of the body are thoroughly supplied with blood, with perfection of consciousness in waking hours, and, in a word, full life. The second of these states is represented in suspended animation, in which the heart is working regularly, but at low tension, supplying the muscles and other parts with sufficient blood to sustain the molecular life, but no more. The third of these states is represented when there is no motion whatever of blood through the body, as in an animal entirely frozen.

The second stage, the stage of passive efficiency, is that in which animation is usually suspended. The condition is a close resemblance to the third stage, but differs from it in that under favoring circumstances the whole of the phenomena of the active efficient stage may be perfectly resumed, the heart suddenly enlarging in volume, from its filling with blood, and reanimating the whole organism by the force of its renewed strength, in full tension.

So far as we have yet proceeded, the whole phenomena of restoration from death are accomplished during this stage. To those who are not accustomed to see them, they are no doubt very wonderful, looking like veritable restoration from death. They surprise even medical men the first time they are witnessed by them.

At the meeting of the British Medical Association at Leeds, a member of the association was showing to a large audience the action of nitrous oxide gas, using a rabbit as the subject of his demonstration. The animal was removed from the narcotizing chamber a little too late, for it had ceased to breathe, and it was placed on the table, to all appearances dead. At this stage I went to the table, and by use of a small pair of double-acting bellows restored respiration. In about four minutes there was revival of active irritability in the abnormal muscles, and two minutes later the animal leaped again into life, as if it had merely been asleep. There was nothing remarkable in the fact, but it excited, even in so cultivated an audience as was then present, the liveliest surprise.

The time during which an animal body may be capable of reanimation from the state of passive efficiency depends altogether on one circumstance, viz., whether the blood, the muscular fluid, and the nevous fluid remain, in a condition which I have defined in another essay as the aqueous condition, or whether these fluids have become pectous. If the fluids remain in the aqueous state, the period during which life may be restored is left undefined. It may be a very long period, including weeks, and possibly months, granting that decomposition of the tissues is not established, and even after a limited process of decomposition, there may be renewal of life in cold-blooded animals. But if pectous change begins in any one of the structures I have named, it extends like a crystallization quickly through all the structures, and thereupon recovery is impossible, for the change in one of the parts is sufficient to prevent the restoration of all. Thus the heart may be beating, but the blood being pectous, it beats in vain; or the heart may beat and the blood may flow, but the voluntary muscles being pectous, the beating is in vain; or the heart may beat, the blood may flow, and the muscles may remain in the aqueous condition, but the nerves being pectous, the circulating action is in vain; or sometimes the heart may come to rest and the other parts may remain susceptible, but the motion of the heart and blood not being present to quicken them into activity, their life is in vain.

The problem physiologically before us is as follows: Can the second or passive efficient stage of life be by any artificial methods secured, so that all the vital parts may be held in suspended animation, working at the lowest possible expenditure of vital power?

Experimental research and experience alike show the certain possibility of temporarily producing this state. Both show that there are agents and agencies by which life may be reduced to the low ebb necessary for suspension of active life, and at the same time the aqueous conditions of the colloidal fluids may be maintained. Cold is the first and most efficient of these agencies. The blood and the colloidal animal fluids derived from it are all held in the aqueous condition of colloidal matter by exposure to cold at freezing point. At this same point all vital acts, excepting, perhaps, the motion of the heart, may be temporarily arrested in the animal, and then some animals may continue apparently dead for long intervals of time, and may yet return to life under conditions favorable to recovery.

In one of my lectures on death from cold, which I delivered in the winter session of 1867, some fish, which, during a hard frost, had been frozen in a tank at Newcastle-on-Tyne, were sent up to me by rail. They were produced in the completely frozen state at the lecture, and, by careful thawing, many of them were restored to perfect life. At my Croonian lecture on muscular irritability after systemic death, a similar fact was illustrated from frogs.

There seems in cold-blooded animals so circumstanced to be no recognizable limit of time after which they may not recover, but there is much skill required in promoting the recovery. If in thawing them the utmost care be not taken to thaw gradually, and at a temperature always below the natural living temperature of the animal, the fluids of the animal will pass from the frozen state through the aqueous into the pectous so rapidly that death from pectous change will be pronounced without perceiving any intermediate or life-stage at all. In warm-blooded animals it is extremely difficult to restore animation after suspension of life by cold, owing to the fact that, in their more complex and differently-shielded organs, it is next to impossible to thaw equally and simultaneously all the colloidal fluids. In very young animals it can be done. Young kittens, a day or two old, that have been drowned in ice-cold water, will recover after two hours' immersion almost to a certainty, if brought into a dry air at a temperature of 98° F. The gentlest motion of the body will be sufficient to restart the respiration and therewith the life.

The nearest approach we see naturally to this state is in hibernating animals. In them the effects of cold in the season for hibernation and the recovery from the torpor are seen even in matured and old animals. In hibernation, however, there is not produced the complete stage of passive efficiency. There is in them a slow respiration and a low stage of active efficiency of circulation. The hibernating animal sleeps only; and while sleeping it consumes or wastes, and, if the cold be prolonged, it may die from wasting. From the sleep of hibernation also the animal can be roused by the common methods used for waking a sleeper, so that animation is not positively suspended.

Returning to the extreme effects of cold on animal bodies, it is hard to say whether an animal like a fish, frozen equally through all its structures, is actually dead, in the strict sense of the word, seeing that if it be uniformly and equally thawed it may recover from a perfect glacial state. In like manner it may be doubted whether a healthy warm-blooded animal, suddenly and equally frozen through all its parts, is dead, although it is not recoverable, because, in the very act of trying to restore it, some inequality in the direction is almost sure to determine a fatal issue owing to the transition of some vital center into the pectous state of colloidal matter. I do not, consequently, see that cold can be of itself and alone utilized for maintaining suspended animation in the larger warm-blooded animals of full growth. At the same time cold will, for a long time, maintain, ready for motion, active organs locally subjected to it. Even after death this effect of it may be locally demonstrated, and has sometimes been so demonstrated to the wonder of the world. On January 17, in the year 1803, Aldini, the nephew of Galvani, created the greatest astonishment in London by a series of experiments which he conducted on a malefactor, twenty-six years old, named John Forster, who was executed at Newgate, and whose body, an hour after execution, was delivered over to Mr. Keate, Master of the College of Surgeons, for research. The body had been exposed for an hour to an atmosphere two degrees below freezing point, and from that cause, though Aldini does not seem to have recognized the fact, the voluntary muscles retained their irritability to such a degree that when Aldini began to pass voltaic currents through the body some of the bystanders seem to have concluded that the unfortunate malefactor had come again to life. It is significant also that Aldini, in his report, says that his object was not to produce reanimation, but to obtain a practical knowledge how far galvanism might be employed as an auxiliary to revive persons who were accidently suffocated, as though he himself were in some doubt.

In repeating Aldini's experiments on lower animals that had passed into death under chloroform with the view of determining what is the best treatment for those human beings who sink under chloroform and other anæsthetics, I failed altogether to obtain the same results when the temperature of the day was high. Noticing this, I experimented at or below freezing point, and then found that both by the electrical discharge and by injection of water heated to 130° F. into the muscles through the arteries, active muscular movements could be produced in warm-blooded animals many hours after death. Thus, for lecture experiment I have removed one muscle from the body of the animal that had slept to death from chloroform, and, putting the muscle in a glass tube surrounded with ice and salt, I have kept it for several days in a condition for its making a final muscular contraction, and, by gently thawing it, have made it, in the act of final contraction, do some mechanical work, such as moving a long needle balanced on the face of a dial or discharging a pistol.

In muscles so removed from the body and preserved, ready for motion, there is, however, only one final act. For, as the blood and nervous supply are both cut off from it, there is nothing left in it but the reserve something that was fixed by the cold; but I do not see any reason why this should not be maintained in reservation for weeks or months, as easily as for days, in a fixed cold atmosphere.

Besides cold there are other agencies which hold the colloidal fluids in the aqueous state, and which, while they suspend the motor function, suspend without necessarily destroying life. Several agents of this class have been discovered.

Mandragora.—The first known of these suspending agents was mandragora. This was known as far back as Dioscorides. Dioscorides states that this vegetable substance may be administered in such a manner that the signs of active life may disappear, and sensibility be so far destroyed that the physician or surgeon may operate on the temporarily insensible without producing pain. The supension of life from mandragora may extend over some hours, and the use of the agent probably was continued until the twelfth or thirteenth century. From the action of it doubtless comes the Shakespearean legend of Juliet. In modern times I have made the wine of mandragora, and found that it has the power originally attributed to it of suspending without destroying active life. The wine from it was the morion of the ancients, the fluid probably that was used by the Jewish women in the times of the Sanhedrim to destroy the sufferings of those who were under torture, and sometimes, perchance, to deceive the executioner and prevent the deadliness of his task.

The plant from which morion was originally made, the *Atropa belladonna* (deadly nightshade), has, in this country, similar properties to its ally, the *Atropa mandragora*. In 1851 I attended at Mortlake two children who were poisoned for a time from eating the berries and chewing the leaves of the nightshade which they had gathered near to Richmond. The children were brought home insensible, and they lay in a condition of suspended life for seven hours, the greatest care being required to detect either the respiration or the movements of the heart. They nevertheless recovered.

Nitrite of Amyl.—In my original researches on the nitrite of amyl, one of the observations which most surprised me was the power of this agent to suspend animation. In the report I made to the British Association in 1864 on this subject I showed that the life of the frog might be suspended for the period of nine days, and yet recovery to full and vigorous life might follow; that the power of suspension, in a lesser degree, could be produced in warm-blooded animals, and that the heart of a warm-blooded animal would contract for the period of eighteen hours after apparent death. The action of the nitrite of amyl in causing suspended animation seemed to be like cold. It prevented the pectous change of colloidal matter, and so prevented rigor mortis, coagulation of blood, and solidification of nervous centers and cords. So long as this change was suspended return of vital function was possible. When the pectous change occurred all was over, and resolution into new forms of matter by putrefaction was the result.

From the analogy of some of these symptoms from nitrite of amyl with the symptoms of the disease called catalepsy, I have ventured to suggest that, under some abnormal conditions, the human body itself, in its own chemistry, may produce an agent which causes the suspended life observed during the cataleptic condition.

Woorali in a similar manner suspends vital function; but as the influence of this agent has been more frequently under observation from other physiologists, I leave it with this mention of it.

Chloral Hydrate has many of the properties of the other substances named above in its power of suspending life. At the meeting of the British Association at Exeter, at which I made the earliest report in this country of Liebreich's remarkable discoveries, some pigeons, which had been put to sleep by the needle injection of a large dose of chloral, fell into such complete resemblance of death that they passed among an audience containing many physiologists and other men of science for dead. For my own part I could detect no sign of life in them, and they were laid in one of the out-offices of the museum of the infirmary as dead. In this condition they were left late at night, but in the following morning they were found alive and as well as if nothing hurtful had happened to them.

Cyanogens.—Cyanogen gas and hydrocyanic acid, deadly poisons as they are, have the power in a singular degree of suspending animation. Combined with a sufficient degree of cold to prevent their evaporation from the body, their suspending power is of the most definite kind. In the laboratory of a large drug establishment a cat, by request of its owner, was killed, as it was assumed, instantaneously and painlessly by a large dose of Scheele's acid. The animal appeared to die without a pang, and, presenting every appearance of death, was laid in a sink, to be removed on the next morning. At night the animal was lying still in form of death in the tank beneath a tap. It the morning it was found alive and well, but with the fur wet from the dropping of water from the tap. This fact was communicated to me by the eminent chemist under whose direct observation it occurred, in corroboration of an observation of mine similar in character.

Alcohol is another substance which holds the vital functions in suspense for long periods of time, the muscles retaining their excitability. In animals killed by alcohol in combination with cold, two influences which act powerfully together in the same direction, I found the muscular excitability could be retained at freezing point for several hours even in birds. A remarkable similar experience, which I have elsewhere recorded, was obtained in the case of an intoxicated man who, while on the ice at the Welsh Harp Lake, fell into the water through a breakage in the ice, and who for more than fifteen minutes was completely immersed. This man was extricated, to all appearances dead, but under artificial respiration, carried out by my friend, Dr. Belgrave, of Hendon, he was restored to consciousness and lived for several hours.

Oxygen.—It is not a little singular that pure oxygen gas possesses the power of suspending life, at all events in muscular fiber, when it is aided by condensation produced by cold; but I am on new ground here, with which I am not so conversant at present as I hope to be.

I have now shown as briefly as was possible that much is known in the world of science in respect to suspension of animal life by artificial means. It will be seen that cold as well as various chemical agents has this power; and it is worthy of note that cold, together with the agents named, is antiseptic, as though whatever suspended living action, suspended also by some necessity or correlative influence the process of putrefactive change. Hence the inference I drew in my lecture at the Society of Arts, that it was within the range of experiment to preserve the structures of dead animals in a form of suspended molecular life.

If the experiments reported from Brisbane be reliable it is clear, I think, that what has been done has been effected by the combination of one of the chemical agents above named, or of a similar agent, in combination with cold, the efficiency of which combination we have seen in many of the experimental facts referred to above. The only question that exists as of moment is, not whether a new principle has been developed, but whether, in matter of detail, a new product has been discovered which, better than any of the agents we already possess, destroys and suspends animation. In organic chemistry there are, I doubt not, hundreds of substances which, like mandragora and nitrite of amyl, would suspend the vital process, and it may be that a new experimenter has met with such an agent. It is not incredible indeed that the Indian fakirs possess a vegetable extract or essence which possesses the same power, and by means of which they perform their as yet unexplained feat of prolonged living burial; but I confess, on reading the Australian narrative, there is nothing suggested by it to my mind that might not be produced by agents already known. Making allowance for what is clearly a very enthusiastic description, there is nothing in an experiment related as made on a dog that might not have been produced by the subcutaneous injection of hydrate of chloral; neither is there anything in other experiments that might not follow from the injection of chloral or wooralI in a cold atmosphere. At the same time it is not also unreasonable to infer that a new product has been found which surpasses any we possess, and suspends animation for a longer period. My faith is most shaken first by the statement that the agent referred to is a secret, for men of true science know no such word; secondly, that the experimenter has himself to go to America to procure more supplies of his agents; and thirdly, that he requires two agents, one of which is antidotal to the other. I can understand the production of a definite effect from a single; and others as well as myself have made out a great many facts respecting the antagonism of one agent by another. But in our researches on antagonistic physiological substances we require the agencies of absorption and circulation of the antidote, and how in a body bereft of motion and practically dead such absorption can take place I am unable to divine.

But even should the description given by the Australian journalist prove overdrawn or imaginative, I am not sorry it has appeared, since it has afforded a reason for relating in a plain and faithful manner to what actual extent human knowledge has been advanced by experiment on the subject under consideration. This duty, though it be but preliminary, is important as an introduction to those great events which in the future are sure to come from the positive results that have already been secured, and for which the world should be prepared, without anxiety or amazement.

EXTIRPATION OF THE KIDNEY.

J. MARION SIMS, M.D, in a letter to the *Medical Record* gives the following account of the operation he lately witnessed in Berlin:

You remember how we were all electrified, about ten years ago, with the news that the daring, dashing Simon had successfully extirpated the kidney. I do not know how often Simon's operation has been performed; but at home I know that it was done successfully by the late Dr. Gilmore, of Mobile, and by our own George C. Peters. It has remained for Dr. Martin, of Berlin (son of the late Prof. Edward Martin), to open up a new field for and a new method of doing this operation. He has now extirpated the kidney five times—four times successfully. And, strange to say, he has done the operation for what is known as floating kidney. His operation before Listerism would have been wholly unjustifiable. But now it is justifiable by its simplicity and its success. It is as simple, if not as easy, as ovariotomy, and quite as successful. Certainly so in Martin's hands. I had the satisfaction of assisting at Martin's fifth operation, on the 19th of April. The operation is by abdominal section. Instead of using a single table, five feet long, for his operation, he has two tables, each about two and a half feet long, end to end, one being a little lower than the other. The patient was chloroformed in her own chamber, and then brought into the operating room, and placed on the table, with the head to the window. The head was on the lower table, the pelvis on the higher one. The head was placed low, with the intention of preventing syncope, the chief source of danger in the use of chloroform. Martin's spray apparatus is an enormous affair that will work for hours. It was placed six feet or more from the patient, and the spray passed over the assistants, and fell on the patient, not in a dense cloud, but in a sort of mist. It seemed to me to be "too much of a good thing."

The operation was begun at ten minutes to 8 A.M., and was finished in twenty-six minutes. It was done slowly and with great painstaking. The incision was begun about two inches above the umbilicus, and extended two inches below it. The bleeding from the edges of the abdominal wound was arrested, as in ovariotomy, with hæmostatic forceps. The peritoneum was then incised. Some folds of small intestine protruded, and were pushed back and retained by a carbolized sponge probang. The kidney was then pushed to the abdominal incision by pressure on the loin behind, where it was seized with a vulsellum, and securely held. The peritoneum investing it was then opened longitudinally; and the kidney was enucleated and brought freely into the peritoneal cavity. Some large veins on its surface were ligated, and its attachments (consisting of renal artery, renal vein, and ureter with cellular investments) were tied in sections, just as we secure a broad pedicle in ovariotomy. The pedicle (so to say) of the kidney, necessarily running longitudinally with the kidney, about three fingers' width long, was transfixed, and tied with five separate ligatures. The kidney was then neatly dissected away from the pedicle and removed. The pedicle was dropped back into its proper place behind the peritoneum; the peritoneal cavity was then carefully sponged dry; and the external wound was closed with interrupted sutures. The sutures and ligatures were carbolized silk. Antiseptic dressings were applied, and the patient removed to her bed.

I saw her twenty-four hours after the operation. Her pulse, temperature, and expression were good; and I thought she would in all probability recover. But I have since heard from Dr. Martin that she died of peritonitis three days after operation. All of Dr. Martin's operations have been done for floating kidney. Heretofore we have told our floating kidney patients that they must accept their condition as incurable. Whether we will readily follow the bold example of Dr. Martin, and extirpate floating kidneys hereafter, is a question.

Dr. Martin had his last case under observation four or five months. He had failed to relieve her sufferings in the least. She complained of weight and pain in the kidney; could not work; and yet was obliged to work to make her living Having exhausted all other means of relief, he proposed the operation, laying before her and her husband its dangers. After due deliberation, they determined to have the operation, being greatly encouraged by the fact that Dr. Martin had already performed it successfully four times.

Dr. Martin says that in one of his cases he had great difficulty in completing the operation. The patient was fat,

the abdominal walls loaded with fat, and it was necessary to make a transverse incision to the right from the median line. The kidney was then safely removed; but the first dressing of the wound, a day or two after operation, showed that the transverse incision had failed to unite; it gaped widely open, and for two or three days afterward the liver could be seen at each dressing, moving up and down with each respiratory act. Notwithstanding all this, the patient recovered without a bad symptom.

We all remember Dr. Miller, of East Broadway, who died some ten or twelve years ago, worn out with kidney disease, complicated with abscess and stone in the pelvis of the kidney. He was an able physician, one of the best of men, loved by his friends and patients, and greatly respected by his confreres. When I first knew him, I too was in bad health, hardly expected ever to recover, and my sympathies were naturally drawn to him. His manly form was bent, and his genial face furrowed with the lines of suffering, as he worked bravely on to the last for the relief of the suffering of others, without the least hope of relief for himself. In such cases as this there is certainly a future for Martin's operation. In such a case as this we might cut down on the kidney, as Martin does, and if we found a stone in the pelvis we could remove it, close up the incision with suture, return the kidney to its place, and leave the case to nature's efforts.

A PLEASANT REMEDY FOR TOOTHACHE.

OUR cook presented herself to me with a swollen cheek asking for something to relieve the toothache, from which she had been suffering all night, and for which she refused to have the tooth extracted. As there was nothing of the usual kind at hand, I was on the point of telling her to call later at my office or go to a dentist, when it occurred to my memory that there was in the house a vial of compound tincture of benzoin, which I had been using upon a young mother as a protection against sore nipples.

After cleansing the decayed tooth, I saturated a pledget of cotton-lint with the tincture and packed it well into the cavity, hoping this would suffice for the time, and bidding her come back in two or three hours if she was not relieved. I was turning away when she remarked that it might not be necessary, perhaps, as the pain was already gone. Supposing her faith had a large share in the relief, I would not allow myself to think that the medicine had anything to do with the cure any more than so much hot water would have done.

But when I arrived at my office there were two other patients awaiting me with the same affliction, and I determined by way of experiment to use the same remedy. To my agreeable surprise both patients declared themselves immediately relieved, and begged a vial of the tincture for future use.

During the winter a number of similar cases applied, and were instantly relieved by the same treatment, all expressing much satisfaction with the remedy.

In December, I told my druggist of the discovery, and recommended him to sell it to any person applying for "toothache drops." This, he reports, he has done, and that every one seems delighted with the medicine.—*T. C. Osborn, M.D., in New York Med. and Surg. Brief.*

ALUM IN BAKING POWDERS.

To the Editor of the Scientific American:

Although the discussion upon the use of alum in baking powder has somewhat subsided of late, I beg the use of your columns for a word more on the subject.

In a circular that was scattered broadcast throughout the West, giving the opinion of several men of science, I find one, purporting to be from a very prominent physician of New York city, in which are the following words (preceded by a statement of the difficulties in the way of effecting a thorough mixture of the ingredients, bicarb. of soda and alum):

"But even if the exact proportions were maintained, the salts formed would retain their injurious properties, as they would dissolve in the gastric juice. The gastric juice contains not only lactic acid, but a large amount of hydrochloric acid, and both the sulphate and hydrate of alumina would be dissolved."

Now I must do the learned physician the justice to say that I do not believe he ever made exactly this statement; for, as has been once or twice explained in this paper, if an alum powder be properly mixed (which was assumed in the quotation), no sulphate of alumina can possibly be present after baking.

The idea that the hydrate of alumina might be dissolved in the gastric juice was a new one to me, and led to an experimental research which it is the object of this paper to detail.

First let me quote from the books a few words concerning the "large amount of hydrochloric acid" in the gastric juice.

In Watts' Dictionary of Chemistry, vol. ii., page 822 (published 1872), I find the following:

"Respecting the nature of the free acid in gastric juice, the opinions of different observers are greatly at variance. Prout and Braconnot concluded from their own experiments that the gastric juice contains free hydrochloric acid. Lehmann, on the other hand, found free lactic acid in this secretion, and attributed the free hydrochloric acid given off on evaporating gastric juice in vacuo to the decomposition of chloride of calcium by the lactic acid."

"Bernard and Barreswil altogether deny the existence of free hydrochloric acid in the gastric juice," and their reasons therefor are given at length.

"Von Grünewaldt likewise maintains that human gastric juice contains no free hydrochloric acid," the acid reaction which it exhibits being due to organic acids, chiefly lactic and butyric.

Two other authorities, Bidder and Schmidt, support the idea of free hydrochloric acid in minute quantities.

One of the latest opinions, and probably the correct one, regarding the state of the hydrochloric acid in the gastric juice, is that it is not exactly "free," in the proper sense of the term, but is combined with the pepsin of the juice, forming a sort of "conjugated acid" called pepto-hydrochloric acid. That some such combination exists is almost proven beyond doubt by the facts cited (Watts' Dic. of Chem., 2d supplement, page 551, published 1875).

From these quotations it is seen that the "large amount of hydrochloric acid" in gastric juice turns out to be a very minute amount, and that probably not a particle of it is free.

But however that may be, the practical question is, Will the hydrate of alumina, as it exists in bread after baking, be dissolved in the fluids of the alimentary canal? This question is important, for, if dissolved, it might produce in some slight degree the effects ascribed to alum; but if it is not dissolved such effects are impossible, and alum, used properly as an ingredient of baking powder, may be considered as harmless. But with the diversity of opinion that is seen to exist regarding the acid of the gastric juice, *a priori* reasoning is of little value; direct experiment can alone be trusted for a reliable answer.

With the view of settling the question beyond dispute, I have, during the last two months, carried on a series of experiments upon living animals. The results obtained, so far as the kind of animal and the kind of powder employed are concerned, are, I think, conclusive.

I ought to say that before commencing this research I had no opinions as to the probable results, and was equally prepared for an affirmative or a negative answer.

The experiments were made with healthy cats, and with a well-known alum powder. (To avoid the appearance of advertising, I withhold the name.) They were conducted in the following manner:

Biscuits were made with three teaspoonfuls of the powder to one-half a pint of flour; that mixture giving a relative proportion of powder about six times that usually employed, and twelve times that directed on the labels.

A different sample of powder (*i. e.*, from a different can or package) was employed for each experiment, to give as broad a range as possible.

Half a dozen biscuits were baked in each batch. Of these, from one to one and a half were fed to a cat that had fasted one or two days; this gave at least half a teaspoonful of powder for the actual experiment.

After digestion had gone on a certain length of time, varying with the different subjects, the cat was killed, and the entire contents, not only of the stomach, but of the small intestines also, were examined for dissolved alumina. This examination was conducted in the most careful manner possible; and the method was that employed for detecting the smallest amounts of alumina (*i. e.*, digesting the mass in water, filtering, evaporating, and igniting to destroy organic matter; extracting with strong acids, filtering, and finally, adding ammonium hydrate).

In every case a large amount of sodium sulphate was found (in solution, as was expected), and also a certain amount of hydrate of alumina, undissolved.

The time allowed for digestion and the results obtained, as copied from my note-book, are as follows:

Experiment No. 1.—Time of digestion, 20 minutes.
Found of dissolved alumina.....Not a trace.
Experiment No. 2.—Time of digestion, 45 minutes.
Found of dissolved alumina.....Not a trace.
Experiment No. 3.—Time of digestion, 1½ hours.
Found of dissolved alumina .....Not a trace.
Experiment No. 4.—Time of digestion, 2 hours.
Found of dissolved alumina.....Not a trace.
Experiment No. 5.—Time of digestion, 2½ hours.
Found of dissolved alumina.....Not a trace.

Somewhat surprised at the uniformity of these results, and thinking that the organic matter of the flour might possibly interfere with the solution of the alumina (or with any detection of it), I made two more experiments of a most crucial nature.

In each two teaspoonfuls of the powder were mixed with water and baked at the ordinary temperature of the oven; the whole mass was then fed to a cat (under compulsion), allowed to digest for a certain time, after which the stomach and intestines were examined as above.

The results from my note-book are as follows:

Experiment No. 6.—Time of digestion, 1¼ hours.
Found of dissolved alumina.....Not a trace.
Experiment No. 7.—Time of digestion, 1¾ hours.
Found of dissolved alumina .....Not a trace.

These experiments seem to establish beyond controversy the fact that hydrate of alumina, when baked, is not dissolved by the juices of the alimentary canal.

I resolved next to determine whether or not the hydrate of alumina in the gelatinous form (unbaked) is soluble in the digestive fluids. Two experiments were made, in each of which two teaspoonfuls of the powder were mixed with water and simply boiled until chemical action ceased.

Each mass being fed to a cat, and the examination conducted as before, the results were:

Experiment No. 8.—Time of digestion, 1 hour.
Found of dissolved alumina .....A trace.
Experiment No. 9.—Time of digestion, 2 hours.
Found of dissolved alumina.....A trace.

These two experiments seem to show that the gelatinous hydrate of alumina (moist and unbaked) is dissolved to a very slight extent in the digestive fluids. Hence the public is advised not to eat bread in the dough; it should always be baked.

Another idea concerning the making of bread with the use of alum powders suggested itself.

The chemical action spoken of above, by which the alum is destroyed and hydrate of alumina and sulphate of soda are found, requires both the presence of water and heat.

Now, if bread is carelessly mixed with an insufficient amount of water, parts of the flour (and with it the powder) remain nearly or quite dry; and, after baking, such bread would contain a certain small amount of alum.

In order to put this to the test, and also to furnish a check on the other experiments with biscuit, I had a batch made exactly like those of the earlier experiments, except that the mixing was done with less water and less thoroughly than usual.

A biscuit of this batch being fed to each of two cats, the following results were obtained:

Experiment No. 10.—Time of digestion, 1¼ hours.
Found of dissolved alumina .....A trace.
Experiment No 11.—Time of digestion, 1½ hours.
Found of dissolved alumina .....A trace.

These results were, of course, exactly what was expected; their main value lies in this, that they prove the entire reliability of the first five experiments.

They also show that to insure the entire absence of alum in the bread, the mixing must be done with plenty of water; and to effect this I would suggest (although I do not consider it an absolute necessity) that the batter, with the powder added, be made rather thin at first, and then thickened by addition of more flour without powder.

The conclusion to which all these experiments lead is obvious. Assuming that the human digestive fluids act in about the same way as do those of the feline race—and I believe that assumption has always been made—it seems to me established, as well by experiment as by reason, that a properly made alum baking powder, as used in making bread or biscuit, is perfectly harmless to the human system. And that some, at least, such "properly made" powders are manufactured and sold in quantity, seems also demonstrated.

In closing, allow me to say, in order to prevent all suspicion, that this investigation was undertaken for the sole purpose of finding out the facts in this matter, one of so great importance to us all; that no party or parties interested in the sale or manufacture of baking powder had any knowledge of the investigation, and that I have received no remuneration for it, or for this article.

Respectfully,
G. E. PATRICK,
Prof. of Chemistry in University of Kansas.

UNIVERSITY OF KANSAS,
DEPARTMENT OF CHEMISTRY,
LAWRENCE, Kansas, June 14, 1879.

MANUFACTURE OF SPIRIT VARNISHES FROM SHELLAC.

OF all the resins used in the manufacture of spirit varnishes, shellac is one of the most valuable, and the numerous attempts made to supersede it by cheaper substitutes have hitherto proved a failure. The shellac varnishes are unsurpassed for permanence, hardness, and luster, and are therefore extensively applied for superior leather and woodwork, etc.

The preparation of spirit varnishes, with an addition of shellac, is very simple, and can be done in the cold. The shellac is first ground to a coarse powder in a hand-mill, thrown into a cask, set in a warm place, and fitted with a tap. The other ingredients and the spirit are then added, and frequently stirred up for several days, till all is dissolved.

The solution is rapidly filtered through paper in a closed tin chest, so that as little as possible of the spirit may be lost by filtration. The following mixtures have proved satisfactory in practice:

VARNISH FOR FINE LEATHER WARES.

Spirit at 95° Tralles	63 quarts.
Shellac	44 lbs.
Sandarach	22 lbs.
Venice turpentine	7 lbs. 10¼ ozs.
Camphor	3 lbs. 4¼ ozs.
Oil of lavender	35 fluid ozs.

FINEST BLACK LEATHER VARNISH.

Spirit at 95° Tralles	63 quarts.
Shellac	46 lbs. 3 ozs.
Sandarach	22 lbs.
Venice turpentine	7 lbs. 10¼ ozs.
Camphor	3 lbs. 4¼ ozs.
Vine black	13 lbs. 2 ozs.

The last-mentioned article is stirred up to a thin paste with spirit, and then poured to the other ingredients.

POLISH FOR FURNITURE.

Shellac (or seed-lac)	13½ lbs. 2 ozs.
Camphor	17½ lbs.
Spirit at 95° Tralles	75 quarts.
Manila copal, in coarse powder,	44 lbs.

For the preparation of pale varnishes the shellac must be previously bleached. For this purpose there are many processes, few of which yield good results. The direct action of chlorine on a solution of shellac cannot be recommended. Bleaching by means of animal charcoal involves great loss, from the quantity of shellac retained in the pores. Certain samples have at first a beautiful silvery appearance, but, on keeping, lose their solubility in spirit.

The following process yields a perfect product: 8¼ lbs. soda-crystals are dissolved in 132 lbs. of water in a copper kettle, and brought to a boil; 27 lbs. 7½ ozs. of good shellac are added and boiled till entirely dissolved; 44 lbs. of water are then added, and the whole is transferred to a beck of soft wood, higher than wide. After three lots have thus been treated, it is let settle for three days, drawn off clear from the sediment, 35 quarts of warm and the same quantity of cold water are added, and lastly 70 quarts of the bleach-lye mentioned below. The whole is well agitated and let stand uncovered for twenty-four hours, or until a sample taken out appears colorless. The liquid is then precipitated by the addition, with constant stirring, of 70 fluid ozs. oil of vitriol in 17 pints of water, adding the acid till nothing more is precipitated. The precipitate is thrown on linen cloths or fine sieves, and washed till all acid has disappeared. When the mass has finished dropping, it is added by portions to boiling water, taken out when soft, and kneaded in a current of cold water till it shows a silvery luster, when it is rolled up into balls, and thrown into clear, cold river water. After soaking for twelve hours it is taken out and dried without exposure to the sun's rays. In order not to soil the shellac in kneading, white wash leather gloves are used.

The bleaching lye is prepared as follows: 98 lbs. 7 ozs. chloride of lime are dissolved in 70 quarts of warm water, standing for some days and stirring frequently. In the same manner 110 lbs. soda are dissolved in 7 quarts of water. The chloride of lime precipitate is drawn off clear, and the soda solution is added as long as a turbidity is produced. The liquid is then drawn off from the deposit of carbonate of lime. [Why not use chloride of soda at once?] If only half the quantity of bleaching liquor is used, so-called bronze shellac is obtained.—*Chemiker Zeitung.*

ANNATTO YELLOW ON COTTON.

BY M. KIELMEYER.

ANNATTO is one of the scanty class of dyes which may be fixed directly and without the intervention of a mordant upon the fiber of cotton. Hence it is capable of numerous applications both in printing and dyeing. For this purpose the annatto is first boiled for some hours in a lye of soda at 5°, 10°, and even 15° Baumé, and the solution, after being strained, is thickened, according to the depth of shade desired, with a larger or smaller quantity of mucilage of gum tragacanth; or if it is to be merely padded in for grounds, it is simply diluted with water. The pieces thus dyed are then printed with the machine; steamed, rinsed; and lastly, in order to develop an elegant aurora shade, taken through very dilute acetic acid. This last process is entirely omitted if a yellowish reflection is desired. But in any case this way of working is by no means certain in its results, the shade being sometimes pure yellow, and sometimes a reddish yellow, and the mixed color, if not used immediately, undergoes alterations the more readily according to its degree of concentration.

This uncertainty, joined to the disagreeable and penetrating odor given off whilst the ware is boiling in the lye, and which cannot be solely due to a little urine said to be added to the annatto, proves that the coloring matter is partially attacked by the energetic and prolonged action of the soda. This alteration is sometimes slight and sometimes amounts to a formal decomposition, which injures or impoverishes the color, and which, if the mixture is preserved in a concentrated state, goes on unchecked after the boiling is over.

The color thus prepared is open to another grave objection: by reason of its great alkalinity it modifies during the steaming process the browns or reds underneath, especially the latter. These shades are not merely soiled by the yellow deposited upon them, but they even sometimes pass into a deep brown, especially when they have been produced with too much wood and relatively too little madder. Hence it has been proposed to partially neutralize the alkaline solution of annatto by means of alum and tartaric acid. This process, which is still used in various establishments, is recommended in "Spirks' Manual of Dyeing and Printing." But in dyeing even with this expedient, ebullition with caustic lye at 10° B. is not dispensed with, and in printing the application color thus prepared keeps still worse than that made up on the old process.

The cooring matter is wasted, either because there remains too little caustic soda as solvent, or because, in presence of the insufficient quantity of sulphate, or tartrate of potash in solution, the aluminate of soda loses its due solubility. This salt is then gradually precipitated in the color, and is deposited in the lines and points engraved on the blocks or cylinders, choking them up and giving rise to new inconveniences.

M. Kielmeyer has observed that a mixture of alcohol and of soda dissolves the yellow and red coloring matters of annatto much more easily and completely than does either of them separately. He has thus found a new formula for annatto yellows which has proved satisfactory in practice. It requires only half the lye used in other receipts, and it secures the permanence of the printing color, reducing to a minimum the injurious influence upon the browns and reds, and increasing the fire of the yellow.

Mix 66 lb. of annatto with 21 quarts of alcohol at 85 per cent. (spec. grav. 0·835), and add, stirring continually, the same measure of boiling water, and half the measure of a soda lye of spec. grav. 1·598 (= 119° Tw.). The whole, which has a temperature of 113° to 122° Fahr., is left to stand all night in a copper pan. The liquid is then decanted off, the undissolved residue collected on a wire strainer, carefully pressed, and treated with 30 quarts of boiling water to wash out any of the solution mechanically adhering. This light yellow watery solution, as soon as it is cold, is added to the alcoholic solution, and the whole is thickened with 105 pints of gum-tragacanth mucilage, at 1¼ oz. per 1¾ pint.

The shade obtained upon cotton with this color, after steaming and washing, is a very intense orange yellow, and is not dear, notwithstanding the use of alcohol, but comes cheaper than the old receipts. If a lighter shade is required, less orange in its tone, and approaching more to a canary yellow, a little aluminate of soda, and some berry liquor, are added to the diluted color. An ammoniacal solution of turmeric must on no account be used. This method of dissolving annatto may also be found useful in silk and wool dyeing.—*Technologiste.*

ON THE COMPOUNDS OF THE TERPENES WITH HYDROCHLORIC ACID.

By WILLIAM A. TILDEN.

In the course of researches which I have for some time been pursuing into the constitution of the terpenes, I have had occasion to prepare and examine the compounds which these hydrocarbons form with hydrochloric acid. The following is a brief account of the chief results arrived at in this direction, and as they possess some interest at the present time, I think it desirable to place them on record:

When dry hydrochloric acid gas is passed into cooled turpentine oil (b.p. 156°) whether from American or French turpentine, the well-known monohydrochloride, $C_{10}H_{17}Cl$, is obtained, melting at 125°, and boiling at about 210°. It is accompanied by liquid products, which yield a large quantity of the same hydrochloride on distillation. This liquid consists of a mixture of cymene, always present in turpentine oil, with liquid compounds of the monohydrochloride and dihydrochloride. The fact that the two chlorides when mixed together unite and liquefy was originally pointed out by Berthelot, and I can confirm this observation. The existence of a liquid modification of the monohydrochloride is doubtful. The solid monohydrochloride is also produced if the turpentine is diluted with benzol or carbon bisulphide before submitting it to the action of the gas.

The result is different when the turpentine is saturated with hydrochloric acid in the presence of some liquid which contains water, or is capable of yielding the elements of water. Thus, when the same turpentine oil is diluted with alcohol, ether, or glacial acetic acid, it yields a purplish colored liquid, which, after exposure to the air for some time, deposits crystals of the dihydrochloride, $C_{10}H_{18}Cl_2$. But it deserves to be noticed that when once the terpene has been made to unite with one molecule of hydrochloric acid no further action of the gas, either in the dry state or in presence of any of the solvents named, is capable of causing it to combine with a second molecule so as to produce the dihydrochloride. There can be no doubt that these two chlorides are of entirely dissimilar constitution, as they behave quite differently under the influence of alkalies, the monohydrochloride being decomposed with difficulty by soda, yielding a crystalline camphene, whilst the dihydrochloride produces chiefly terpinol $C_{10}H_{17}(OH)$. The dihydrochloride referred to possesses the same properties, whether prepared from lævo- or dextro-gyratory turpentine oil. Its solution in alcohol is optically inactive. The crystals melt at 48° in an atmosphere of hydrochloric acid, and by heat are readily decomposed into hydrochloric acid and a hydrocarbon. This dihydrochloride is also obtained by the action of hydrochloric acid gas upon crystallized terpin hydrate and upon terpinol. (*Journ. Chem. Soc.*, June, 1878.)

If, in place of turpentine oil, one of the terpenes of higher boiling point is operated upon no monohydrochloric can be obtained. Thus, the terpene from orange oil boiling at 176° was dried and saturated with hydrochloric acid. The resulting solution was colorless, and after exposure to the air for a day or two, was found to contain no chlorine at all. But when the same terpene was mixed with ether, and treated with the gas, a solid mass of colorless crystals remained after evaporation of the ether. It was a somewhat unexpected discovery that these crystals consist of the same dihydrochloride already described, that is obtained under the same circumstances from turpentine. There is, however, some difference observable in the behavior of the terpene from the orange and those from the turpentine oils; for whilst the former yields a nearly theoretical amount of crystallized dihydrochloride, the latter produce a considerable quantity of liquid of deep color. This coloration is characteristic of the action of hydrochloric acid upon terpinol, $C_{10}H_{18}O$, or $C_{10}H_{17}OH$, as shown in a recent paper (*Journal of the Chemical Society*, June, 1879), and it appears indicate the formation of an intermediate product which is to probably the same in both cases.

In order further to establish the identity of the dihydrochlorides thus obtained from the two classes of terpenes, the dichloride prepared from the orange oil and from turpentine oil were decomposed by water. 50 grms. of each boiled with 500 c.c. of water were found to be decomposed at the same rate and in the same manner, yielding a mixture of hydrocarbon (terpinylene, $C_{10}H_{16}$, b.p. 176°), and terpinol ($C_{10}H_{17}O$, b.p. 210°). The terpinol was recognized in each case by its conversion into crystallized terpin by the action of sulphuric acid and water. The terpenes from juniper oil (b.p. 156°), lemon b.p. 176°), bergamot (b.p. 176°), and caraway (b.p. 176°) yield this dihydrochloride, as also does the terpene (b.p. 174° to 176°) contained in the *ol. pini sylvestris* of pharmacy and a terpene (b.p. about 176°), obtained from rosin spirit.

The single exception is the "sylvestrene" discovered by Atterberg in Swedish turpentine, and which I have since recognized in Russian turpentine. The dihydrochloride which this terpene yields melts at 72° to 73°, and although decomposed by alkali it yields a hydrate which is apparently not common terpinol. If it should prove to be distinct from ordinary terpinol it is probable that it may be convertible into a new terpin. I am about to make experiments with the object of settling this question, which possesses some interest.

The terpene dihydrochloride described in this paper is decomposed by simple application of heat, and by prolonged boiling in a flask fitted with condensing tube is resolved into hydrochloric acid and a hydrocarbon, terpinylene, $C_{10}H_{16}$, which boils at 176°. A portion of the hydrocarbon is at the same time converted into viscid polymerides. Terpinylene cannot, however, be made to recombine with hydrochloric acid so as to reproduce the crystalline dihydrochloride.

Thus, terpees of the two classes, boiling respectively at 156° and 176°, and very diverse in their optical properties, may all, by this process, be converted into one and the same inactive hydrocarbon.

I cannot conclude without expressing my thanks to Mr. G. H. Morris and Dr. G. Harrow for valuable assistance in these experiments and in other parts of the same research.—*Chemical News.*

INDELIBLE INK.

THE *Apotheker Zeitung* gives the following formula: 1·75 grms. aniline black are ground up with 60 drops hydrochloric acid and 42 grms. alcohol, and the liquid is diluted with a hot solution of 2·5 grms. gum arabic in 170 grms. water. If the aniline black solution is diluted with a solution of 2·5 grms. shellac in 170 grms. spirit instead of gum water, the result is an ink suitable for writing on wood, brass, or leather.

PREPARATION OF CHEMICALLY PURE TARTARIC ACID.

By FICINUS.

THE decomposition of the calcium salt with sulphuric acid, or of the lead salt with sulphureted hydrogen, does not yield a pure product. The author proposes to decompose the zinc salt with sulphureted hydrogen. Zinc tartrate is a scarcely soluble salt, easily obtained pure even from very impure materials. The zinc sulphide obtained as by-product serves for the development of hydrogen sulphide, yielding a solution of zinc chloride, which is used for fresh precipitations of zinc tartrate.

VISCOSITY.

By ANTONY GUYARD.

THE author considers that viscosity, like porosity, is capable of modifying chemical reactions, and possesses a true catalytic power. Glycerine, as a viscous substance, acts in two manners upon the reactions of metallic salts; it modifies the behavior of these salts with known reagents because it is a non-volatile organic body, and especially because it is a viscous substance. Thus, if glycerine is mixed with a solution of chromic chloride, and ammonic chloride and ammonia are added, the whole forms an emerald green liquid, from which chromic oxide cannot be precipitated, just as if tartaric acid had been used instead of glycerine. Analogous reactions are manifested with some other metallic salts when mixed with glycerine and ammonia, or soda.

When glycerine and the alkalies have no solvent power upon hydrated metallic oxides, precipitation takes place in the ordinary manner. If a large excess of glycerine is mixed with solutions of a double sulphate of potassa, of titanic acid, sulphate of alumina, ferric chloride, nitrate of lead, or stannous chloride and ammonia is added, all these oxides remain in solution, and are precipitated neither by boiling nor by the addition of water. But if hydrochloric acid is added enough to saturate at once the ammonia and the glycerine, and the acid is again super-saturated with ammonia, the oxides are precipitated as if the glycerine were not present. The addition of an alkaline chloride in sufficient excess to solutions of a metallic oxide in glycerine and caustic alkali determines its precipitation. The author has not succeeded in utilizing these reactions in the quantitative separation of metallic oxides.

PRECIPITATION OF LIME BY ALKALINE CARBONATES.

By E. DRECHSEL.

THE precipitation of calcic carbonate is complete in the cold in the course of fifteen minutes if aided by stirring. It may be effected indifferently either by sodic or ammonic carbonates in the presence or absence of ammonia or sal-ammoniac. The calcic solution should be introduced into the alkaline carbonate, pouring in a small quantity of the former only at first and stirring for about five minutes before adding more. The solubility of calcic carbonate in alkaline liquids is very trifling.—*Journ. f. Prakt. Chemie.*

NEW ORGANIZED FERMENT OF UREA.

By P. MIQUEL.

THE author has found in sewage an organism of the bacillus class, which, like *Micrococcus urea*, possesses the power of resolving urea into carbonate of ammonia, though quite distinct for the micrococcus in its physical aspect. It appears, therefore, that two microscopical species possess approximately the same physiological function.

ULTRAMARINE.

By MM. KNAPP and EBELL.

THE following are the conditions on which the formation of crude ultramarine and its transformation into blue are effected.

1. It is not necessary that the elements of the mixture should be in determined and unvarying proportions. On the contrary, they may fluctuate within very wide limits.

2. It is essential that both the silica and the alumina should be brought to a state of chemical dissociation.

3. Soda ought to be added in quantity sufficient to form, in addition to the silicate, a sufficient quantity of sulphuret of sodium.

4. Crude ultramarine ought always to be able to give off abundance of sulphureted hydrogen.

5. Oxidized compounds of sulphur are integrant parts neither of crude ultramarine nor of ultramarine blue.

6. No sulphuret of aluminum is formed during the calcination.

7. The elements of the mixture ought to be in the state of very fine powder, and very intimately mixed together, in order that the product may be homogeneous and of a uniform blue.

8. The temperature of the calcination should be sufficient to decompose the clay entirely, and to form sulphuret of sodium, but the mixture must never be fritted, much less fused. If this heat is reached the conversion into blue is no longer possible.

9. For the formation of crude ultramarine the calcination must be kept up for an hour; it is not produced by an instantaneous action.

10. The transformation of crude ultramarine into ultramarine blue is effected at a medium red heat by the action of an anhydrous acid or of chlorine, and is always attended with the separation of free sulphur and the formation of a corresponding salt of soda.—*Dingler's Journal.*

ORGANIC RESISTANCE TO A BOILING TEMPERATURE.

CH. CHAMBERLAND has found a microscopic organism which lives in nearly all liquid solutions of organic matter, provided that they have been previously neutralized by a solution of potash. It produces germs or spores which, when placed in neutral media, resist a boiling temperature for several hours. A temperature of about 115° (239° Fahr.) kills them very rapidly.—*Comptes Rendus.*

STARCH-LIKE GRANULES IN EGGS.

IN 1866 M. C. d'Areste found some granules in the yolks of eggs which presented many characteristics of starch. Their existence was at first contested, but afterward admitted, and various attempts were made to account for them. He has lately continued his investigations, and finds that the granules are insoluble in alcohol, ether, or any of the other common solvents of fatty matters. They are colored blue under the influence of any solution of iodine. Sulphuric acid decomposes them; but acetic acid does not affect them. The largest grains swell under the influence of potash or soda, and resume their primitive volume when placed in alcohol. When their form is very regular they act upon polarized light like grains of starch. They may be separated from the yolk by first hardening it in water of 75 or 80° (157 to 176° F.) so that the globules of the yolk are transformed into hexahedral prisms. These globules are first treated by ether, which dissolves the oil and a portion of the fatty matters, and then by absolute alcohol, which removes the rest of the fatty materials and contracts the albuminous substances, producing partial ruptures, from which the starchy globules escape.—*Comptes Rendus.*

GOLD IN PETROLEUM.

ACCORDING to the *Bergmann*, Mr. J. Turnbridge has extracted $34 worth of gold from a ton of the residues from petroleum stills. The source of the petroleum was not ascertained.

LIMIT OF THE SEPARATION OF ALCOHOL AND WATER BY DISTILLATION.

By J. A. LE BEL.

THE greatest degree of concentration obtained by repeated rectifications was 96·5 per cent. On rectification over quicklime an alcohol of 98·5 was produced. When this spirit was submitted to fractional distillation the water passed over first, and the residue was the most highly alcoholic. After three rectifications the first portions marked 97·4 and the residues 99·3. The author finds that amylic alcohol from wines has not the repulsive odor of fusel oil or of the crude amylated alcohols of (beet-root) treacle. This odor, and possibly the injurious physiological action of the higher alcohols, may possibly, he considers, be due to the presence of certain empyreumatic compounds.

EFFECTS OF INHALING OIL OF TURPENTINE.

By M. POINCARE.

THE author has examined 282 workmen who use this oil in their trades, and has kept animals for several months in a medium strongly charged with its vapor. Among the workmen the symptoms were headache, dizziness, watery eyes, weakness of sight, especially in artificial light, cough, and troubled digestion. In most cases the constitution became habituated to this agent, but sometimes a change of employment was necessary. The animals experimented upon remained in a normal condition if good ventilation was maintained. In confined air death ensued in consequence of congestion of the brain, lungs, etc.

TARTAR EMETIC IN DYEING.

DR. REIMANN points out that tartar emetic, as used in cotton-dyeing, serves not to fix the aniline colors themselves, but merely to fasten the tannin, thus playing the part of an indirect mordant. Several experiments have been instituted

at the Färber Akademie in order to ascertain whether this application of antimony can be pronounced injurious to public health. It was found that water, in which cotton yarns dyed with aniline colors on a mordant of tannin and tartar emetic had been steeped, or especially boiled, gave distinct indications of antimony when tested in ordinary manners. The quantity of the metallic compound fixed on the fiber seems, indeed, far too trifling to have any effect upon human health.—*Reimann's Färber Zeitung.*

SOME EXPERIMENTS ON ALLOYS OF SILVER WITH EMBRITTLING METALS.*

By ALEXANDER E. OUTERBRIDGE, JR.

IT is a fact very well known to metallurgists that the presence of certain base metals in refined gold and silver, even in such small percentages as to render their detection difficult, if not impracticable, by ordinary chemical tests, will nevertheless exercise such an injurious effect in regard to ductility, hardness, etc., as to render the metal totally unfit for coin or the industrial arts, thereby necessitating the removal of these impurities by oxidizing fluxes, or other equivalent means.

It is also well established that during the process of removing these impurities (technically called "toughening"), an inevitable, though variable loss occurs.

This loss may be directly traced to three causes:

First. To the formation of volatile compounds of gold or silver with the baser metals.

Second. To the violent action on the surface of the metal during the decomposition of the oxidizing agent, thereby causing minute particles of the molten metal to be sprayed from the surface.

Third. To the upward current of air and flame sweeping over the surface of the molten metal in the pot drawing into the flue the vaporized metal and the fine spray.

These vapors are carried by the strong draught of the wind furnace out of the chimney, where they partially fall, in a sort of fine rain, upon the roof of the mint and neighboring building, and a larger portion is carried into free space and lost.

Attempts have been made to recover the metal thus dissipated by means of shelves and other devices arranged in the flue, with but partial success, and they have the practical disadvantage of tending to impair the draught in the wind furnace.

It was to overcome these difficulties that an apparatus was devised by the writer to prevent the metallic vapors and gases arising from the melting pot from escaping into the flue at all by drawing them off into a suitable condensing chamber.

The chief assayer of the mint, after examining the drawings, laid the whole matter before the late director of the mint in Washington, who in turn instructed the writer to have an experimental apparatus constructed, and "after it is finished to have it thoroughly tested by careful trials under the direction of the melter and refiner."

In accordance with these instructions the apparatus was made and erected at one of the furnaces in the melting department, and the trial tests were commenced on February 5th, 1878, and continued as opportunity offered until they were suspended, owing to the unprecedented increase in the regular work consequent upon the passage of the Bland Silver Bill.

The arrangement of the experiments having been intrusted to the writer, he prepared a schedule of the proposed work, which was approved by the officers directly interested. It was designed by the writer that these trial melts should also subserve a broader purpose of furnishing reliable data as to the relatively injurious effects upon refined silver of small but known percentages of such base metals as were supposed to impair its good qualities. It is this secondary portion of the work which is now submitted, albeit in an incomplete form, to the readers of the *Journal of the Franklin Institute.*

The schedule as far as completed includes the preparation and subsequent examination, analysis and refining, of alloys of silver with arsenic, antimony, bismuth, and lead.

About one thousand (1,000) ounces of silver was adopted as the normal weight of refined metal to each experimental melt.†

With respect to the success of the apparatus, the writer desires merely to refer by permission to the brief extracts from letters of the officers, who observed its operation, which accompanied his report made to the late superintendent of the mint. These will be found in the foot note.‡

He also desires to say that the credit for the success which attended the tentative tests of the apparatus is largely due to the excellent suggestions in the mechanical details which were made by Mr. Samuel James, the master mechanic of the mint, to whom was intrusted the construction of the machine, thereby materially improving the original design.

FIRST EXPERIMENT—SILVER ALLOYED WITH ARSENIC.

Although the metal arsenic has a great affinity for silver, it will not readily combine with it in an open crucible, owing to its extreme volatility. The following expedient was therefore resorted to, with success:

A bar of silver which assayed 999 thousandths fine and weighed 100·46 oz. (troy) was first melted with 3 oz. of metallic arsenic in a black lead pot, with a lid luted on with fire clay, and bound tightly with a metal strap.

The fire was brought up gradually for two hours, then a good white heat for half an hour; it was then allowed to slowly die out; the crucible remaining in its place was agitated in order to bring fresh surfaces of the molten silver in contact with the confined vapors of arsenic. A lump of charcoal was put in the crucible to prevent oxidation of the arsenic. When the pot was cold the "king" of metal was broken out, cleaned, and weighed. It turned the scale at 102·98 oz., showing that 2·52 oz. of arsenic had combined with the silver.

The exterior surface of the "king," as it is technically called, presented a light gray color. On breaking it open this light shade was observed to extend to a depth of about 1-20th of an inch; the interior showed a darker gray color, indicating that the surface contained a smaller proportion of arsenic. In order to ascertain this a piece was assayed from the surface and another from the interior, with the following result:

Surface ....975 fine.
Interior.....971 fine.

It is possible that the portion of the metal touching the sides of the pot remained hot somewhat longer than the center, owing to the fact that the pot remained in the fire until the whole had cooled. The volatile arsenic may thus have been driven (or distilled) in to the central portion of the solidifying mass.

The broken surface of the metal presented a clearly crystalline structure, and, although by no means so ductile as fine silver, it was far more so than could have been anticipated. The metal hammered and rolled without splitting. The solution in nitric acid was perfectly clear like fine silver, and no trace of arsenic could be detected by the eye or smell. Two samples of the alloy were preserved for future comparisons; one was rolled into a ribbon, to show the malleability; the other broken, to show the fracture.

In the next operation, 952 oz. silver, 999 fine, were melted in a No. 40 black lead crucible. When the fine silver was perfectly fluid, the king of silver-arsenic alloy, weighing 102·29 oz., was added to the mass; the metal was then stirred and a sample for reference extracted.

The metal was finally toughened in the ordinary way, using niter and sand. At the end of one hour and a half the flux was skimmed from the surface and the metal poured into large shoe moulds.

The sample taken from the mass after the "king" was thoroughly incorporated, assayed 995¼, which agreed closely with the theoretical fineness, viz., 996. This sample was reserved for future experiments.

The mass metal, after having been toughened as above stated, was cast into bars, and assayed 998. The metal was then perfectly ductile, and no trace of arsenic could be detected by the eye.

The sweep resulting from the grinding of the crucible weighed 28½ lb. avoirdupois, and contained 97·712 grs. of pure silver per pound avoirdupois. The sweep from the grinding of the ashes in the furnace weighed 58 lb., and contained ·720 of a grain per lb. The entire weight of silver in both sweeps was thus found to be 1·12 oz. troy.

SECOND EXPERIMENT—WITH ANTIMONY.

The toughened silver resulting from the previous experiment was manipulated in the following way:

One bar, 998 fine, weighing 119·60 oz., was melted in a closed crucible with 3 oz. of metallic antimony, with the addition of charcoal to prevent oxidation. The pot was allowed to cool slowly (as in the previous experiment with arsenic), and the king of alloyed metal resulting was found to weigh 122·39 oz., showing that 2·79 oz. of antimony had combined with the silver. The king assayed 975 fine, and contained 2½ per cent of antimony.

The metal was remarkably tough and ductile, rolling almost as well as fine silver; fracture crystalline and coarse.

Next a melt of silver bars, 998 fine, weighing 786·08 oz. (resulting from the silver-arsenic experiment), was melted in a No. 40 black lead pot, under charcoal. As soon as it was fluid the king of antimonic-silver alloy was added. The whole was thoroughly stirred and a sample cast out for future experiments. This sample assayed 994 fine.

The metal was now exposed to a hot fire for a period of one hour and a half, a current of air being allowed to pass over the surface. Niter was added occasionally in small quantities for the purpose of burning off the charcoal. During the entire time, the antimonic oxide was seen rising to the surface of the metal, and burning off with quite copious fumes, passing up the condensing tube. The water in the glass condensing chamber became very turbid, and the filter soon clogged up with a heavy sediment. The toughened metal was then cast into bars, and assayed 998 fine, and presented all the characteristics of fine silver.

The material on the filter was dried and collected. It weighed 1·15 oz. An examination under the microscope showed that it was profusely sprinkled with extremely minute globules of metallic silver. These particles are nearly perfectly spherical, conclusively proving that they have been volatilized and condensed. The majority of the globules were very much smaller than the interstices of the filtering cloth, thus leading to the inference that a portion of the silver may have passed through the wash water, and thus escaped into the well. This fact was conclusively proved in the next experiment by collecting some of the water percolating through the filter, allowing it to settle, and recovering a button of pure silver from the sediment.

An analysis of the material showed that it contained one-seventh (⅐) silver, the remainder being antimonic-oxide, colored by charcoal dust. The filter was burnt, and added to the precipitate; the metal was reduced to a button and cupelled. It weighed 13-100ths ounce.

THIRD EXPERIMENT—WITH BISMUTH.

One bar of toughened silver (resulting from previous experiment) assaying 998, weighing 137·77 oz., was melted in a closed (luted) crucible with 3 oz. of bismuth in the same manner as before. The king of alloyed metal weighed 140·73 oz., showing that 2·96 oz. of bismuth had combined with the silver. The king resembled exteriorly the antimonic-silver alloy, but on cutting into the metal, it was found (unlike the antimonic-silver) to be exceedingly brittle or "short," like pie-crust. The fracture presented a coarse grain with a lusterless or earthy surface. The color of the metal when hammered was very dark or leady, and the strips had a somewhat greasy feeling.

The sample assayed 975 fine, showing about 2½ per cent. of bismuth. A melt of 888·62 oz. toughened silver, 998 fine, was then made in a No. 40 pot; as soon as it was melted the king was added. It was thoroughly incorporated with the mass by stirring; a sample was taken out and assayed 996 fine. The sample still showed plainly the "shortening" effect of bismuth; the fracture was crystalline and fine, the color was but slightly impaired and the assay slip rolled tolerably well.

The mass was now exposed to a high temperature for about three-quarters of an hour. Niter was then added copiously, finally a small quantity of sand to thicken the flux just sufficiently to skim. The bars were cast into moulds, cleaned, and weighed. On assaying the first and last bars it was found that but little or no improvement in fineness had occurred. The first bar assayed 996, the last 996½; they were consequently reported 996¼.

The difficulty was, according to Professor Booth, that the niter being thin, failed to hold the oxide of bismuth formed by its action. As soon as the oxygen (formed by the decomposition of the niter) had been driven off, the reducing action of the black-lead pot caused the bismuth to go back to the metallic state, when it again formed an alloy with the metal. (This metal was afterward refined to 999½ by the use of bone ash.)

As the examination of the precipitate collected on the filter in the previous experiment had revealed the fact that the volatilized silver globules were so minute as to lead to the inference that a portion had passed through the interstices of the filtering cloth, an effort was made to recover any particles thus escaping. The fact that the metal did so escape was conclusively proved in this experiment and a portion of the fugitive particles recovered. In this case, the water percolating through the filter was caught in a large iron tank, the overflow from this tank discharged into a second filter composed of two thicknesses of fine twilled linen. The water in the tank was allowed to remain at rest for several hours and then drawn off. On testing the sediment in the tank, it was found to be rich in silver; it was then dried, treated with carbonate of soda in a sand pot. A button of silver was obtained which was purified by cupellation and then weighed ·07 of an ounce.

The sediment collected on the second filter was treated as above with a similar result. Finally, a portion of the water escaping through the second filter was collected and silver was traced here also.

Although many of these particles or globules are so minute that a microscope with a good magnifying power is required to see them, they may be readily and beautifully exhibited by agitating a beaker glass full of the water in the sunlight, when thousands of brilliantly scintillating points of light are seen reflected from the extremely minute faces of the silver pellicles. A similar effect is described by Faraday, in "Philosophical Transactions," 1857. By treating very dilute solutions of gold with phosphorus he obtained the metal diffused through the liquid in extremely fine particles. These particles, he says, 'are easily rendered evident by gathering the rays of the sun (or a lamp) into a cone by a lens, and sending the part of the cone near the focus into the fluid; the cone becomes visible, and though the illuminated particles cannot be distinguished, because of their minuteness, yet the light they reflect is golden in character, and seen to be abundant in proportion to the quantity of gold present." He further says that portions of gold, in such a fine state of division that "they have not as yet been seen by any power of the microscope, may have the presence of the diffused solid particles rendered evident by the sun in this way."

SUPPLEMENTAL EXPERIMENT WITH THE SILVER BISMUTH ALLOY.

As already stated the alloyed metal resulting from the experiment with bismuth was found to retain four and a half thousandths of bismuth which the niter had not removed. In accordance with the suggestion of Professor Booth, the metal was again melted and covered with a coating of bone ash, holes were made in this covering with an iron poker and grains of niter were dropped through to the exposed surface of the molten metal; as fast as the bismuth was oxidized it was absorbed and held by the bone ash (the principle being the same as in cupellation): at the end of about one hour, the bone ash was taken off, a fresh supply of niter and sand added, the second flux skimmed off, and the metal cast into bars. The condensing apparatus was not used, as it was supposed that the bone ash covering would protect the metal from volatilization. It was found, however, that a loss of 1·42 oz. occurred. During the toughening, samples were taken out at intervals of twenty minutes and assayed; the first showed 997, the metal still remaining brittle. The second sample assayed 997¾, and was also brittle. The third assayed 999 and showed some brittleness, but the fracture presented a closer grain than in the two former samples. It was still quite unfit for coin ingot metal.

The bars when cast had all the appearance of fine silver, being perfectly ductile; they assayed 999½ fine. This result seems to indicate that small percentages of bismuth affect silver more injuriously, both in regard to its ductility and in respect to the difficulty of its elimination, than equal proportions of arsenic or antimony.

FIFTH EXPERIMENT—SILVER AND LEAD.

A bar of silver, 999½ fine, weighing 82·83 oz., was melted under charcoal with 3 oz. of pure lead in a closed crucible. The king of alloyed metal weighed 85·61 oz., showing that 2·78 oz. of lead had combined with the silver.

The exterior of the king had a white or frosted appearance. On cutting an assay chip, the metal was found to be very brittle, having a dull leaden color. The fracture was not very clearly crystalline, but seemed more like the effect of a mechanical tearing away of the metal. A similar effect was noticed in rolling and hammering the assay slip, for while it broke to pieces under the hammer, it seemed to be crumbly (like dry bread) rather than brittle. Under ordinary inspection, however, it would have been simply classed as brittle. The sample from the king assayed 960, or contained 4 per cent. of lead. A melt of bars, 999½ fine, weighing 931·53, was then made in a No. 40 black lead pot. The king was added, mixed, and a sample cast; this sample assayed 996¼. It was fairly ductile, had a good luster and color, but when compared with a strip of fine silver it was appreciably (though not greatly) darker in tint.

A coating of bone ash was put on and the nitering performed as in the previous case. Samples were taken out and assayed from time to time until the metal was found to be sufficiently refined. In about one hour the bone ash was removed and the bars cast. Owing to some accidental cause (probably the want of a sufficient covering of charcoal), the metal "spurted" or "vegetated" on the surface, rendering it necessary to remelt and recast the bars, and when this was done they presented to the eye all the characteristics of perfectly pure metal. When the small chip was cut off for assay, there was no evidence of a tendency to crystallization, and the sample was laminated into a ribbon 1-100th of an inch in thickness, without splitting. The assay showed that the metal was now refined to 999½ thousandths.

To briefly recapitulate, the results obtained in this work—which the writer desires shall be regarded rather as preliminary, and therefore capable of possible modification on more extended investigation—are these:

It was ascertained that the arsenical silver alloy, contrary to the general expectation, was the least volatilizing in silver in comparison with more refractory metals, and that the alloy might contain one per cent. of arsenic (silver 990, arsenic 10) without materially injuring the ductility; but if car-

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* Made at the United States Mint, Philadelphia.

† Although the assay department long since adopted the French system of weights, the gramme and its decimals, the troy ounce is still regarded as the unit or standard mint weight, and is accordingly employed in these experiments.

‡ Professor Booth, the melter and refiner, in whose department the tests were made, after indorsing the accompanying report as expressing the results of the trials in their integrity, says: "In relation to the trial of apparatus, I remark that the principle underlying Mr. Outerbridge's process is sound, viz., to recover volatilized precious metals by drawing off the possible vapors above gold and silver in a crucible and wholly condensing them. I remark further that his mode of effecting the result is, I believe, new, simple, effective, and inexpensive," etc.

Mr. Wm. E. DuBois, the chief assayer, after alluding at some length to the evils which the apparatus was designed to overcome, says: "These two points being kept in view by all concerned, it was interesting to observe the changes and modifications by which the system (as all systems are) was step by step improved and simplified, until it seems nearly complete. Certain it is now in such a satisfactory shape as would warrant its introduction into the mints and assay offices and refineries generally; for it is well known that the evil which it abates is not confined to this institution."

ried to two and a half per cent., the mixture was quite brittle.

The antimonic-silver alloy caused a very much greater loss of silver, and yet its brittling effect was much less than had been anticipated. Bismuth was the most brittling, and in this experiment proved by far the most difficult to remove by fluxes that operated effectively upon the two former.

Lead causes a greater loss than any of the former with the exception of antimony. The brittleness of those was crystalline, of this rather crumbly or amorphous, yet three parts in a thousand did not spoil the ductility.

While it has been a source of regret to the writer that these trials have been suspended, for the reason given, prior to the completion of the prearranged schedule, he is led to hope that they may form the entering wedge into future investigations, which are much needed to afford a complete elucidation of the difficulties that beset the manipulator in the precious metals, whether in the preparation of coin metal, ornamental ware, or gold leaf, in the want of ductility of the alloys, and he is also encouraged to think that they may serve to throw a passing glimmer of light upon this rather obscure subject, in support of which hope he refers the reader to an extract on this subject from the letter of the assayer, already alluded to.*

TABLES.

The following tabular statement shows the gross weight of metal operated upon in each experiment and the amount of fine silver contained therein, together with the gross weight and amount of fine silver recovered from the toughening process:

FIRST EXPERIMENT.	OUNCES. Gross Weight.	Fine Silver.
Refined silver, 999 fine	1052·46	
Metallic arsenic	2·52	
Total weight of metal operated on	1054·98	1051·40
Total weight of metal recovered in the form of bars, samples, and "sweep."	1053·32	1051·15
Apparent loss of silver		·25
SECOND EXPERIMENT.		
Refined silver, 998 fine	905·68	
Metallic antimony	2·79	
Total weight of metal operated on	908·47	903·86
Total weight of metal recovered	903·16	900·21
Apparent loss of silver		3·65
THIRD EXPERIMENT.		
Refined silver, 998 fine	1026·39	
Metallic bismuth	2·96	
Total weight of metal operated on	1029·35	1024·33
Total weight of metal recovered	1027·18	1023·31
Apparent loss of silver		1·02
FOURTH EXPERIMENT (*Supplemental*).		
Silver-bismuth alloy, 996¼ fine	1020·56	1016·73
Total weight of metal recovered	1015·79	1015·31
Apparent loss of silver		1·42
FIFTH EXPERIMENT.		
Refined silver, 999½ fine	1014·36	
Metallic lead	2·78	
Total weight of metal operated on	1017·14	1013·85
Total weight of metal recovered	1011·78	1010·78
Apparent loss of silver		3·07

—*Journal Franklin Institute.*

CRYSTALS EXTRACTED FROM CAST-IRON BY MEANS OF ETHER OR PETROLEUM.

By J. LAWRENCE SMITH.

ON treating comminuted cast-iron with these solvents, on the spontaneous evaporation of the liquid, the author obtained acicular crystals, consisting principally of sulphur, and absolutely similar to those extracted by the same process from meteoric iron. M. Berthelot, to whom the author had forwarded specimens of the crystals, stated that he had obtained similar bodies by the action of pure ether upon octahedral sulphur and upon anhydrous iron sulphides. It thus appears that even neutral solvents do not in all cases act by simple solution upon the bodies with which they come in contact, but effect also a chemical alteration.

OIL AND SOAP FROM THE EUCALYPTUS.

OUR readers of course have heard of the *Eucalyptus globulus*, the Australian "blue gum" tree, and its alleged powers of destroying the germs of fevers and other infectious diseases. Some of these accounts have been "too good to be true." The eucalyptus, like most other novelties, has suffered the persecution of exaggerated praise and impossible expectations, leading to the usual reaction of an unjust poohpoohing of its real merits.

It is already planted extensively, and we are told, successfully, on the Pontine Marshes, that great pestiferous plain, flat as a lake, that extends for thirty miles from Cisterna to Terracina, between Rome and Naples. Groves of eucalypti are to be planted on the great central plain of Cyprus in order that our new protectorate, or possession, or annex, or whatever else it should be called, may cease to have the marvelously anomalous climate it has lately possessed—a climate inducing all the ills that flesh is heir to, when it operates upon the constitution of Englishmen who are engaged as special correspondents to liberal newspapers, and which, on the other hand, is so balmy, genial, and salubrious to all who write for the conservative press; a climate engendering liberal agues and diphtheria, while it cures conservative gout and rheumatism. We hope the eucalyptus will have its desired effect, if only for the future credit of our craft in the direction of decent truthfulness.

How can this or any other tree disinfect a fever-laden atmosphere? is a question that may be fairly asked, and it is not difficult to answer. We know that carbolic acid and other similar hydrocarbons are disinfectants; and though we obtain our supplies of carbolic acid from coal, which is now a mineral, it was, as we all know, originally a vegetable. Paraffine oil is a disinfectant; so also is turpentine; and the same is the case in a greater or lesser degree with all the volatile and aromatic resins and oils. This brings us at once to the question of whether the eucalyptus yields a notable quantity of such volatile oil or hydrocarbon. If so, it may be separated and examined by the chemist. Such separation and demonstration of properties, if properly carried out, must be far more satisfactory than any vague expressions of opinion concerning its curative influences. The subject has been thus investigated by some Australasian chemists.

Before stating the results of their researches, we should explain that eucalyptus is the name of a genus of plants which includes many species; just as quercus is the name of another genus, the oaks, of which there are many species; or castanea, of the chestnut genus, including the species horse chestnuts, edible chestnuts, etc. In like manner we have *eucalyptus globulus, eucalyptus resinifera, eucalyptus mannifera*, and a number of others, in all of which the first name is that of the genus or the generic name, the second that of the species, or the specific name. The last two of the above names translated into English become the "resin-yielding eucalyptus" and the "manna-yielding eucalyptus." We have heard more of the globulus than of other species, mainly on account of the fullness of its foliage, its more ornamental character as a shrub when young, and its very rapid growth; but it is by no means the richest as regards the important property of yielding large quantities of volatile oil. The species that appears to be the richest is the *eucalyptus amygdalina*. This yields nearly five times as much volatile oil as the more popular *eucalyptus globulus*. M. Bosisto, at the instance of Baron Ferdinand von Mueller, Director of the Victorian Botanical Department at the Exhibition of 1862, distilled the foliage of various species, and obtained the following results: *E. amygdalina* yielded 3·313 per cent. volatile oil, *E. oleosa* yielded 1·250, *E. goniscalyx* yielded 1·060, *E. globules* yielded 0·719, *E. obliqua* yielded 0.500. The smaller percentage of oil in the *E. globulus* is to some extent compensated by the vigor of its growth and the early abundance of its foliage. The proportion of oil in all the species varies with the season and locality of growth. We are told that *E. rostrata* (not named above), though "one of the poorest in oils, is nevertheless important for malarial regions, as it will grow well on periodically inundated places, and even in stagnant water not saline," and that *E. oleosa* from the desert regions of extra-tropical Australia, might be planted and reared on other barren lands for the sake of its oil.

Mr. Osborne has shown that the eucalyptus oils are valuable solvents, and may be used as the medium of varnishes. The following are some of the substances which they dissolve—camphor, pine resins, mastic, elemi, sandarach, kauri, dammar, asphalt, xanthorrhœa-resin, dragon's blood, benzol, copal, amber, anime, shellac, caoutchouc, and wax, but not gutta percha. The above-named gums, resins, and gum resins arranged in the order of their solubility. The list being headed by camphor and pine resins as the most soluble, and concluded with caoutchouc and wax as the least, shows that these volatile oils have considerable resemblance to turpentine, and it is probable that they may substitute or even supersede this important volatile oil.

The quantity obtainable from the *E. amygdalina* (3⅓ per cent.) is so large that if the trees were grown for their timber, or for sanitary purposes, or for both combined; and if, in addition to these uses, an annual crop of such oil is obtainable from their leaves, their commercial value will be immense, especially if the oil can be used in the place of turpentine in ordinary house-paints, and is of less objectionable odor. We are even told that the aroma is positively agreeable. What a domestic revolution will be effected when sweet odors arise from the paint pot, and house painting time shall be a period of enjoyable domestic perfumery! But this is not all.

The eucalyptus is not only to supply us with a sweet-scented medium for paints and varnishes, but also with the basis of soft soap, and many important medicines. After distilling the oil from the leaves and twigs, these may be burned, and from their ashes 5 to 27 per cent. of potash is obtainable. We may safely accept these figures, derived from laboratory research, as fair data for calculating practical results, seeing that the commercial production of the oils and the alkali involves no new operation, but is a subject well understood, and every manufacturer can state the difference between large scale production and laboratory figures. In these cases the difference is very small. The future of this new branch of industry depends upon the possibility of acclimatizing these Australian trees in our own and other European countries. If the published accounts of their rapid growth and of the value of their timber are to be relied upon, they are likely to supersede the majority of our old fashioned forest trees. Thus, as long ago as May, 1876, a meeting of the Manchester Field Naturalists and Archæological Society was told that at Hyères, in the South of France, M. Cotambert had planted on one hectare of land 3,000 seedlings of the *E. globulus*, which in three years had grown from the height of a few inches up to thirty feet, the stems having a circumference of about fourteen inches at three feet from the ground, and that the wood is used in Algiers for carriage-building. But the climate of the South of France is very different from that of our country, and we have yet to learn whether, among the many species of eucalyptus that are so widely diffused over the varying climate of Australia, there are any that we can cultivate profitably, or whether we are to be dependent on southern countries for this, as for so many of our other raw materials. We must not forget that these aromatic volatile oils, when properly refined, are available for lamps; and thus the eucalyptus promises something to fall back upon when our American cousins have pumped out all the subterranean reservoirs that at present supply their oil wells. It may be long ere this occurs, but it must be so at last, seeing that oil does not grow in the earth, and the largest supplies are but limited.—*London Grocer.*

FLOWERS AND THEIR UNBIDDEN GUESTS.

THOSE who are familiar with Mr. Darwin's charming work on the "Fertilization of Orchids," and who have watched the progress of physiological botany since its publication in 1862, cannot fail to be struck with the abundance of evidence which has been adduced in support of his broad generalization, that "nature abhors perpetual self-fertilization." In the vegetable world, observation has been constantly accumulating proof of the necessity of intercrossing with independent sources of life for the preservation and multiplication of species.

Self-fertilization, it may be here mentioned, lies in the production of fruitful germs by a single flower. Cross-fertilization implies the production of similar germs from different flowers of the same species, and this necessitates the transference of the pollen from the anthers of one flower to the stigma of another. The chief agents in this work of cross-fertilization, which is essential to the health and vigor of plants, are insects. Variety of form, and brilliancy of color, and richness of odor in flowers are not provided only for the gratification of man. They have higher ends to serve in the economy of nature, and, except in the realms of poetical imagination, no flower is ever "born to blush unseen," or "waste its sweetness on the desert air." Attracted by their bright colors and sweet scents, insects feed upon the nectar which is secreted within the blossoms, and so become the means of transporting the pollen from flower to flower, and the contrivances by which they are induced to visit the nectaries, and thus secure the processes of fertilization, are alike manifold and wonderful.

Nature, however, must furnish means of protection as well as of attraction. There are multitudes of insects which would prove highly injurious to flowers, by robbing them of their nectar, without conferring any corresponding benefit in the work of fertilization. The blossoms, therefore, must be protected from such visitants, and that many curious contrivances exist for the exclusion of these unwelcome guests, recent observations have shown. As Darwin opened up a new and unexplored region by his observations on the attractive properties of flowers, so Dr. Kerner, of Innsbrück, in a recent work on "Flowers and their Unbidden Guests," has introduced us to a new field for interesting research, by pointing out some of the curious contrivances of Nature for guarding her treasures against the inroads of such insects as would effect only useless plunder.

The questions which are opened up by the study of such contrivances have wider bearings than any which have yet been followed out, such as the influence of structural development upon the variation of species, and, consequently, upon natural selection. Of this we may rest assured, that no morphological characters are without some functional significance in the path of natural progress. But more extended observation on the biology of plants must be made before any very certain conclusions on such subjects can be reached. The chief result of Dr. Kerner's delightful work is to show that, as the presence of nectar in a flower furnishes conclusive evidence of cross-fertilization through the agency of animal life, so, almost as certainly, will there be found some contrivances by which the nectar is preserved from attacks that would prove injurious to the continuance of the species.

It may not be out of place here to remind our readers that they need not be deterred from the observation of these contrivances by the fear of scientific lore. The mastery of a few simple terms and details of botanical structure, with the aid of the beautiful plates which accompany Dr. Kerner's work, will enable the most unlearned to prosecute such investigations with ease, while the pleasure of their summer rambles will be enhanced a thousandfold.

Some idea of the value of protective agencies may be formed by considering the extreme delicacy of many of the floral organs which are engaged in the work of fertilization. Leaves are no less essential than flowers to the continuation of a plant's existence, for in them are formed the materials for the flower. A leaf, however, may be damaged by being partially eaten, or may undergo change by the production of galls, without any fatal effect to the whole. In the case of the organs within the blossom, their delicacy is such, that the smallest change in size or shape, or the slightest disturbance through external influences, during the period of fertilization, may render the whole apparatus powerless to effect its purpose.

In the common louse-wort (pedicularis), for example, when fertilization takes place in the individual flower, the result seems to depend upon a single movement of the corolla. The upper petals of this flower form a beak-shaped tube, in which the dusty pollen will be found at the end of the blossoming period. The fertilization then depends upon an angular movement of the corolla, by which the pollen is rolled upward through the tube to the stigma. This angular movement must be of definite strength to accomplish its purpose, and this would be rendered impossible if the corolla were in any way injured or disturbed during the flowering period. Hence the necessity of protection from the injurious influences of weather or the attacks of animals. In many species of plants the fatal effects which would result from extensive destruction of leaves by animals are guarded against by the presence of alkaloids and other chemical compounds in the cellular juice, rendering them unpalatable. Many of the larger grazing animals would sooner go without food than touch the leaves of these plants.

Of the plants which form the staple food of herbivorous animals there will always be a sufficiency to secure their continuance after animal wants have been supplied, but the question of leaf preservation is of importance in its bearing upon flowers, inasmuch as these are developed from the materials which the leaves supply.

It is in flowers, however, that the most varied contrivances for the preservation of their organs against the attacks of animals of all kinds are to be found. In some we find the result obtained by the secretion of distasteful substances, such as alkaloids, resins, and ethereal oils. It is remarkable that, as a rule, herbivorous animals have a distaste for flowers. Any one may observe how carefully cattle and sheep avoid plucking most of the flowers which abound in their pasturage. The beauty of the blossoms has no attraction for them. The richness of the odors seems only to repel them. It is worthy of note, however, that it is only when the flowers are fresh that they are thus carefully avoided by ruminant animals. When their work is done and they are dried up the chemical compounds which protected them in the field are either volatilized, or so changed that they lose their scent, and, mixed with hay, they are readily eaten. While, however, the ethereal oils which abound in flowers render them repulsive to grazing animals, they serve to attract others, especially insects, whose visits are needful for the work of cross-fertilization.

Wingless animals are in all circumstances unwelcome

* I took a particular interest in this investigation for two reasons: First, I was sure that we knew too little practically about the effect of a small presence of such metals as arsenic, lead, etc. That is, we depended too much upon supposition, as to the extent or the degree in which they were injurious to the precious metals for coining purposes. It was worth while to make some severe and decisive tests upon that point. * * * As you have already seen by Mr. Onterbridge's report in detail, the alloying and volatilizing experiments were made with four metals in conjunction with silver, namely, arsenic, antimony, bismuth, and lead. These are the chief enemies that trouble the camp of the silver miner and refiner, Nor are they less dreaded at the mint, since a small proportion of either will make our gold or silver refractory, brittle, crystalline, or crumbly. * * * We must have ductile metal to work with. Hence these experiments have for us, as I have said, a twofold interest, as hitherto there have been no trials that we know of, at home or abroad, on any considerable scale, or in proper bulk. * * * On the whole we have learned a good deal, and I hope these experiments, without respect to the saving from waste, may be made accessible to parties interested in our own land and in foreign parts.

guests to flowers. They reach the blossoms only by climbing; and even if they did no harm to its organs while sucking the nectar, they frequently could not reach the flower of another plant without descending and crawling along the ground.

This process, besides involving waste of time, would expose the pollen attached to them to the risk of being rubbed off, or destroyed by contact with soil or moisture. Moreover, these insects pay no heed to the kind of flowers which they visit. They pass from one to another indiscriminately, and it would thus be by mere chance that the pollen would reach another flower of the same species. It is a very remarkable fact that the winged insects which do the work of cross-fertilization confine themselves, in their rapid flight from flower to flower, to blossoms of the same species. The bee, for instance, will confine itself during a single journey to the flowers of one and the same species, and never seems tempted to turn to others till it has returned to the hive with its spoil.

The most unwelcome, and yet the greediest of wingless insects, are ants. They are gifted with exceptional powers of smell, and are therefore attracted to any sweet substance from a great distance. Dr. Kerner relates an interesting example of this. In the house of one of his colleagues at Innsbrück, some dried pears which were laid upon the ground floor were immediately attacked by ants. To prevent their interference, the pears were transferred to a room on the second story; but the following day the ants were busy at work. On investigation it was found that they had made their way up-stairs by means of the bell-wire, which communicated with the garden, and passed by the window of the room in which the pears were deposited. These busy little creatures, moreover, do not suspend their activity during the night, as is proved by observation on night-blooming flowers, while their perseverance is only equaled by their industry.

To prevent the useless depredations of such insects, numerous protective contrivances exist. For instance, in Physgelius capensis, a Cape flower which is rich in nectar, all access to the coveted food during the process of fertilization is rendered impossible to insects like ants by the ovary forming, as it were, a plug at the base of the tubular corolla, while stronger insects can without difficulty insert their probosces into the nectar pits. But so soon as fertilization takes place and the flowers fell off, the obstruction is removed, and the ants are free to avail themselves of the nectar, which they do greedily. The common antirrhinum furnishes a more familiar example of such mechanical protection. Here it is secured simply by the closure of the lips of the corolla. They remain closed so long as the stigma is not fertilized; and while bees can easily effect an entrance by forcing open the compressed lips, such insects as ants are effectually excluded. So soon, however, as the stigma has been covered with pollen, the tension of the corolla is relaxed, the lips separate, and the ants are free to carry off the nectar at they please.

The visits of such insects are generally prevented by the secretion, on various parts of the plant, of a viscid substance, which bars their passage in attempting to reach the flowers. Stems and leaves, flower-stalks and bracts, and frequently the calyx, the external sheath of the flower itself, afford protection in this way. The Rock-lychnis (Lychnis viscaria) and the beautiful Butter-wort (Pinguicula vulgaris) may serve as illustrations. Various ends are served by such secretions; and in the case of pinguicula, when we remember that it is one of the insect-eating plants, we can scarcely agree with Dr. Kerner in regarding the viscid secretion on its leaves as having, for its "primary function," the exclusion of insects from the flower.

This, however, is not the least important of its functions. By its stickiness it forms an effectual trap to prevent their upward progress. Of other wingless insects, among the most formidable, from the extraordinary rapidity with which they multiply, are aphides. Every cultivator of roses knows too well what the green fly means. These little creatures will be found swarming on the under sides of leaves, on flower stalks, and even on the exterior of the flowers; but fortunately they are rarely to be found within the blossoms, whose juicy tissue they would speedily pierce and destroy. With soft bodies and long delicate limbs, they avoid all except smooth surfaces. Bristles or hairs form a sufficient barrier against their attacks.

Another set of guests which are unwelcome to flowers, because useless for the purposes of cross fertilization, are soft bodied animals, such as snails, slugs, and caterpillars. Viscid secretions would not be effectual in excluding these visitants, especially snails, which can easily overcome the obstruction by coating the sticky surface with their own slime. An effectual bar to the approach of such animals is secured by thorns, prickles, and bristles. They are at once repelled by any sharp point coming in contact with their bodies. The arrangement of these means of defense is sometimes striking in adaptation.

While thorns, which protect the leaves behind them, are pointed horizontally or in an ascending direction, an array of prickles and bristles on various parts of the plant will be found pointing downwards, so as to prevent the ascent of animals which crawl from beneath. The individual flower heads of composite species, such as thistles, furnish familiar examples; and it will generally be found that the accumulations of these obstacles are greater the nearer the approach to the flower head. In many plants whose stems and leaves are perfectly smooth, the involucre, or combination of bracts which surround the flower, is fully furnished with such means of defense.

The protective appliances which we have hitherto noticed have had in view the exclusion of animals which creep upward, and are therefore developed on the path which they must tread. But flowers are exposed to the visits of numberless flying insects, which are too small to effect any good purpose in the process of fertilization. We find, therefore, that inside the flowers themselves there are numerous provisions for the exclusion of such guests. These generally consist of soft hair-like formations (trichomes), developed in various forms on different portions of the floral organs. One of the most striking of these formations is a circular collection of hairs having the free ends pointed inwards, yet so arranged as to leave an aperture, though which larger insects may thrust their probosces in reaching the nectar. These circular arrangements have been termed weels, from their resemblance to the so-called wicker baskets which are used by fishermen for catching eels. In the dead-nettle (Lamium), in most species of speedwell (Veronica), in passion flowers, and in lilies, these formations may easily be observed.

In various positions and arrangements, as may be necessary for protecting the organs of fructification, these hair-like processes are developed within the blossoms, forming weels, nets, trellises, latticea, or fringes of countless forms and of marvelous beauty. The same ends are served by the peculiar formation of different parts of the flower. These are often manifestly designed to protect the nectar from the ravages of unwelcome guests. They are curved or dilated, laminated or arched, thickened or constricted, forming grooves, tubes, tubercles, chambers, pouches, "in such endless variety of form as to render it a difficult task to give a general view of them."

A very remarkable provision of nature in the case of night blooming flowers consists in a temporary suspension of the functions of parts which serve to attract insects. During the sunshine they are safe from the attacks of enemies; while with evening, these functions resume their activity, and allure the insects that search for nectar after sunset. The coloration of these night blooming flowers is peculiar. In the daytime, insects are doubtless attracted by variety of color as well as by scent, and there can be no doubt that they discriminate colors. Sir John Lubbock has shown that this is the case with bees. He placed some honey upon slips of glass, with paper of various colors underneath them. After he had accustomed the bees for a time to find the honey upon the blue glass, he washed it clean, and placed the honey upon the red glass instead. The bees on returning did not fly at once to the red glass, as they should have done if they had been guided alone by the sense of smell. They went first to the blue glass, and it was only after they failed to find a supply on the accustomed color, that they sought it elsewhere. Variety of color would be useless in the twilight or during the night; and therefore among flowers which blossom after sunset, the inner surface of the petals is simply white, the outer surface being of some inconspicuous color, as greenish brown, dirty yellow, or ash gray. During the daytime, when these flowers are closed, they remain unobserved, appearing as if withered; while in the evening, when open, their white petals render them distinctly visible.

Dr. Kerner has made several night blooming species of silene a special study. In these plants each flower generally lasts three days and three nights. During the day they are curled up, and appear as if wrinkled and withered; but as soon as evening approaches the wrinkles disappear, the petals become smooth, the flowers unfold in all their freshness; and during the period of fertilization their internal organs fulfill their functions in exact correspondence with the opening and shutting of the corolla. In the daytime these flowers are entirely destitute of fragrance; but in the evening, simultaneously with the opening of their petals, they inhale a rich odor. They are safe, therefore, from the attacks of enemies during the sunshine; while their viscid footstalks protect them from such wingless visitants as might be disposed to find them out at night. By this temporary suspension of function they are reserved for the visits of insects which prove useful in promoting the great ends of cross fertilization.

Many of the peculiarities of structure to which we have referred have other ends to serve than those indicated. For instance, minute prickles, and bristles, and hair like trichomes, as well as peculiarities of formation in various parts of the blossom, fulfill the function of what Dr. Kerner calls path pointers. The benefit or injury which may result to a flower from visits of insects which promote the work of cross fertilization, depends upon the mode of their entrance. If they should reach the nectar without coming in contact with the organs of fructification, there would be manifestly useless waste. To prevent this, many contrivances exist. In one species of pedicularis, for example, a groove, bordered on each side by a swelling, runs along the median line of the lower lip of the corolla. To effect fertilization, the bee must pass its proboscis down this groove in reaching the nectar; for only in this manner can it cause the upper lip to incline forward, so that the pollen may fall out of the anthers, and the stigma be brought into contact with its body. Should the bee insert its proboscis higher up, above the groove, this motion of the corolla could not take place, and the mechanism by which fertilization is secured would not be brought into play. So secure this object, therefore, the upper lip is studded with small sharp teeth, which compel the bee to find an entrance in the only way which can effect the process of fertilization.

Many other interesting examples might be quoted. Enough, however, has been said to indicate the interest of such investigations. Oftentimes our interpretation of the designs and secrets of nature may fail in accuracy, and generalizations may require to be modified; but we should remember that, without careful observation of processes and patient accumulation of facts, we cannot reach a higher and truer appreciation of her marvelous laws. The humblest observer of the flowers of the field may take part in such investigations, and find pleasure in adding to the stores of our knowledge regarding the many wonderful appliances by which nature secures the fertilization and the preservation of her species. "The beauty and the poetry of flowers," as Darwin truly says, "will not be at all lessened to the general observer" by investigation of the minute details of structure, and observation of the multiplicity of means by which nature accomplishes her ends.—*Chambers' Journal.*

WORN OUT PASTURES.

"He who by the plow would thrive,
Himself must either hold or drive."

This time-honored maxim, although true, as a rule, has one exception at least, for Judge Crossett, of Duxbury, secures some of the most thorough plowing, without doing either. Nor does his hired man put a hand to the plow or guide the team. And, moreover, they often cultivate lands that an ordinary team could not reach; such as old worn-out pastures, rough and rocky, and so covered with brakes that the grass is completely crowded out. The judge took me up to his field to see his tillers of the soil, who furnished their own board and camp on the ground where they labor, at the same time manuring the land wherever they work. A portion of his pastures that had grown up to brakes and briers was fenced off by itself, and here we found the queen of the field, with all her train, busily tearing up the mould, making it as mellow as an ash heap, and following each brake root until the last vestige was consumed. Likewise the briers were destroyed, root and branch, leaving the ground so thoroughly plowed that even the stones were thrown up from their beds, some bowlders as large as a twelve quart pail.

A short distance below was another field where they had been at work the fall before. Here half a dozen shotes had been put upon an acre of brakes and briers the first of August, and by the middle of October the whole was completely plowed, every brake and brier taken out by the roots, while the shotes had gained in flesh and were in a thriving condition. The next spring the judge planted this to potatoes and fenced off about five acres more, that was completely covered with brakes and briers, with here and there a patch of grass that had nearly run out for want of manure. He put in a sow and twelve shotes, scattering a little corn among the brakes the first day or two, but after that gave no other feed. They began in the midst of the thickest portion of the brakes and briers, making clean work as they went, feeding on these roots and the patches of grass. This field was on a steep hillside, where it was almost impossible to draw manure, and the patches of grass had been mowed over until they bore but a very small crop. But these shotes were covering them with a topdressing that would restore the land to its original fertility. It is well worth some travel to see such work.

There are hundreds of acres of land in this vicinity that is so completely covered with brakes that not one spire of grass can grow. Once it was excellent pasture, but the brakes have crowded in, year after year, and the land being too rough and stony to plow, there seemed to be no remedy but to "fall back in good order," and give the brakes the field. One farmer who formerly kept a dairy of twenty-five cows, now can keep only twelve, because the brakes have overrun the pasture. How to kill brakes has been a difficult question to answer, but Judge Crossett has solved the problem. Fence in a few shotes and give them nothing else to eat, so they will be obliged to tear up the brake roots or starve—literally to "root hog or die"—and very soon the brakes and briers will give place to a good crop of grass. But be sure and give these plowmen plenty of pure, cold water. This is indispensable.

Now do not these experiments teach us that we must go back to some of the old methods from which we have departed? By pasturing neat cattle exclusively, there are high knolls and steep hillsides that become worn out and barren; also, rough, rocky land where the brakes and briers are crowding out the grass, year by year. A few sheep will nip the grass on the high knolls, and in every nook and corner, biting close and loosening the roots, as well as giving it a good dressing of manure. Then again the hogs that are plowing the ground and destroying the brakes and briers, will be quite as healthy as those that are shut up in pens to wallow in mud and filth.—*G. W. K., in N. E. Farmer.*

THE CARE OF HORSES.

THE discussion of the better methods of "treating the horse in health and disease," which lately occurred at the house of Wm. E. Nason, first vice-president of the Franklin Farmers' Club, was one of the most entertaining of the winter's course. Mr. Nason, who, from boyhood, has spent his life among horses, has, owing to kindness, good judgment and constant watchfulness, been remarkably successful in their management, having experienced almost no losses from death or disease during the past twenty-five years. He believes that a well-bred horse, one having good lungs and ample muscle, if well kept, can be made to do almost double duty, for a short time, without serious injury, provided he is properly cared for at the end of his extra effort. He recently had occasion to send two or three of his teams to catch a railroad train, where the endurance of the horses was put to the severest test, and yet, by giving them the best of care at the end of their journey, he had saved them uninjured. Very hard work or very profuse sweating, for a limited period, will kill neither man nor beast, if proper precautions are observed in the after treatment; but it will not do to sit in a draught of cold air to rest and cool off; nor is it safe to allow a tired and sweaty horse to stand, even for five minutes, at the end of his journey, without attention.

In choosing a horse, he would select one with a light head and lean cheek, not meaty in the face. He should be high in the withers, with full, but not a bony breast, broad, deep chest, with plenty of room for lungs, and body well ribbed up. The arms should be heavy with muscles, but the legs should be flat, or look so from a side view, with four good feet; such a horse will be serviceable and enduring.

One of the first signs of disease in a horse is a loss of appetite. A healthy horse will be always ready for his food; and when one is found with food in his manger rejected, it is a sure sign that his case needs immediate attention. He does not believe, with many, that the horse is peculiarly subject to disease, but that horses are naturally as healthy as other domestic animals. Almost every disease from which they ever suffer is caused at first by a cold, the result of ill-treatment on the part of their keeper or driver. Colds and fevers can be broken up, if taken in season, and even founders should not destroy the value of a horse, if discovered early.

To break up a recent cold, make the horse sweat, get him in the same condition he was in when he took the cold, and then take care of him. Do what ought to have been done at first; rub him down and dry him off thoroughly, without letting him become chilled.

In feeding horses, let the mangers be low down, and the floor had better be a little pitching towards the head than much the other way. His own stalls have a lower floor pitching to carry the water back, but the inclination is taken out of the planks on which the animals stand by sawing them thickest at the rear. Then, by laying the planks a little distance apart, they have a dry, comfortable platform to stand upon, one that will not unduly strain the muscles and tendons of the legs. If a horse comes in very tired, he gives him his hay on the floor, so that he can lay down while eating, preferring to suffer the waste of a pound of hay rather than make the horse swallow his food in a hurry, in order to lie down to rest himself. Horses on a farm, not subjected to severe labor, may be treated very differently from those kept in a livery stable. Driving horses should have their food concentrated and not in large bulk. When he was a boy, horses suffering from heaves and founders were the rule rather than the exception in farming sections. Now the reverse is true, owing to the increased knowledge concerning the treatment of horses. If he has a hard day's work for a horse to do, he feeds light in the morning, gives a very little water, and very little food or water till the hard drive is over. Then, after making the horse perfectly comfortable by grooming and drying, give him a liberal feeding and a good night's rest, when he will be ready for another hard day's work.

The old, but too common custom of some farmers, to feed heavily upon oats just before starting a grass or hay fed horse on a journey, and then flooding the stomach and intestines with water, is all wrong. Horses that scour on the road may be cured by a judicious system of feeding and watering. One advantage he claimed for cracked corn over fine meal is that the corn is less freely floated out of the stomach by an excess of water.

He always waters his horses before feeding, though they frequently drink but little, especially in the morning. Waters but little at a time afterwards, perhaps two or three quarts to

a drink. Has never had a barn warm enough to keep horses comfortable in the coldest weather without blankets, but if building again would provide for taking off the chill by running hot water pipes in front of the stalls. Is not much in favor of clipping horses in winter, and would never shear the hair from the legs to save work in grooming. A little warm water to remove ice and dirt is better than the shears. The long hair on the fetlock is needed there to protect the skin from wet and cold.

In blanketing a horse, be sure to cover the chest, bringing the blanket well round in front. Prefers dry grain to cold, wet feed, though warm cut feed is very satisfactory for a breakfast in cold weather. In keeping farm horses, he would give the corn whole and on the ear, when they had plenty of time for eating it. Horses will grind corn as fine as any mill, if we will give them time enough.

Interfering, he believed, was usually the result of a low, weak condition. Give the horse life and a loose harness, and he will usually take care of his legs.

Mr. Hood followed by saying that he believed cribbing was a habit caused by foul stomach brought on by improper feeding. He never knew a case of cribbing till he came to the United States, where horses are given ground feed and wet hay. The habit of interfering may be aggravated by a low condition, but there is a marked difference in horses, some being subject to knocking their legs together, even when hog-fat, while others never strike under any circumstances.

Munroe Morse said he had never owned but one horse, but his experience was against the habitual use of blankets in the stable.

A. W. Cheever also opposed the use of blankets in the stable, except when a horse comes in cold and wet. He had formerly used blankets, but his horses always shivered under a cold harness put on in place of a warm blanket, and they evidently felt the cold on the street, when not at work, much more keenly than since blankets in the stall had been discarded. Every stable should be warm enough to keep a healthy well-fed horse comfortable, without an artificial covering. Peddlers', butchers', and grocers' horses that are blanketed nights often suffer severely on cold days while on duty in the harness, especially when the stops are frequent and the drives short.

Milton Allen stated that he had dispensed with blankets some years since, and found his team doing better without than with them. J. E. Grant, E. L. Metcalf, and several others had had a similar experience.

Mr. Nason said that, if one can dispense with the use of blankets in the stable, it will equal an annual saving of four dollars per horse, as it will cost that for blankets and surcingles. He spoke also of the great value to a horse of a good grooming after a hard day's work in a hot day. It is as refreshing as a bath to a fatigued man, and will often give a tired horse an appetite for his supper, which, without the grooming, he would refuse. One of the great mistakes horse owners make is in not noticing whether every meal is eaten up clean, so that they may be warned of the first approach of disease, and be able to treat it before it becomes seated, and the animal past recovery.

The subject was an interesting one, and was treated with much satisfaction to the farmers and others present.—*N. E. Farmer.*

WINNERS OF THE DERBY AND THE OAKS.

SIR BEVYS.

THE winner of the one hundredth Derby, the most valuable that has yet been contested, is a son of Favonius and Lady Langdon, and is, therefore, half-brother to Hampton, one of the best stayers of modern times. He was bred by Lord Norreys, and was, we believe, leased by him to Mr. Acton for his racing career. He is a brown colt, of so dark a color as to be nearly black, and has one white heel. Standing a shade under fifteen hands three inches, he has such a short back, and displays so much muscle and power, that he looks smaller. His legs are short, well formed, and look like standing any amount of work, and his rather large open feet were well adapted for the trying journey over heavy ground.

The previous performances of Sir Bevys certainly did not point to the probability of his gaining the highest honors of the turf. His first appearance was in the Fern Hill Stakes, in which he was unplaced, and he was equally unsuccessful in a Two Year Stakes at the Newmarket July Meeting, which was won by Massena. Later in the year he seemed to improve, as at the Newmarket First October Meeting he carried off a Maiden Sweepstakes, beating nine opponents, and a fortnight later he was only beaten a head by Out of Bounds, when attempting to give 2 lb. to that very useful filly.

Sir Bevys had not started this season prior to the Derby, so it is not surprising that 20 to 1 was obtainable about him up to the fall of the flag, and he possibly owes his victory more to the weakness of the opposition than to his own excellence, though it is only fair to say that he got off very badly indeed, and yet made up his leeway, and won with apparently a good deal in hand. The most gratifying circumstance in connection with the success of Sir Bevys is that he was ridden by George Fordham, who, at his nineteenth attempt, set the seal to his fame, and met with a reception that has never before been accorded to any jockey on his return to weigh in. Sir Bevys has several engagements, the most important being the Grand Prize of Paris, which will be run for to-morrow (Sunday), and which appears quite at his mercy, and the St. Leger, in which Wheel of Fortune will prove a far different opponent from any that he had to meet at Epsom.

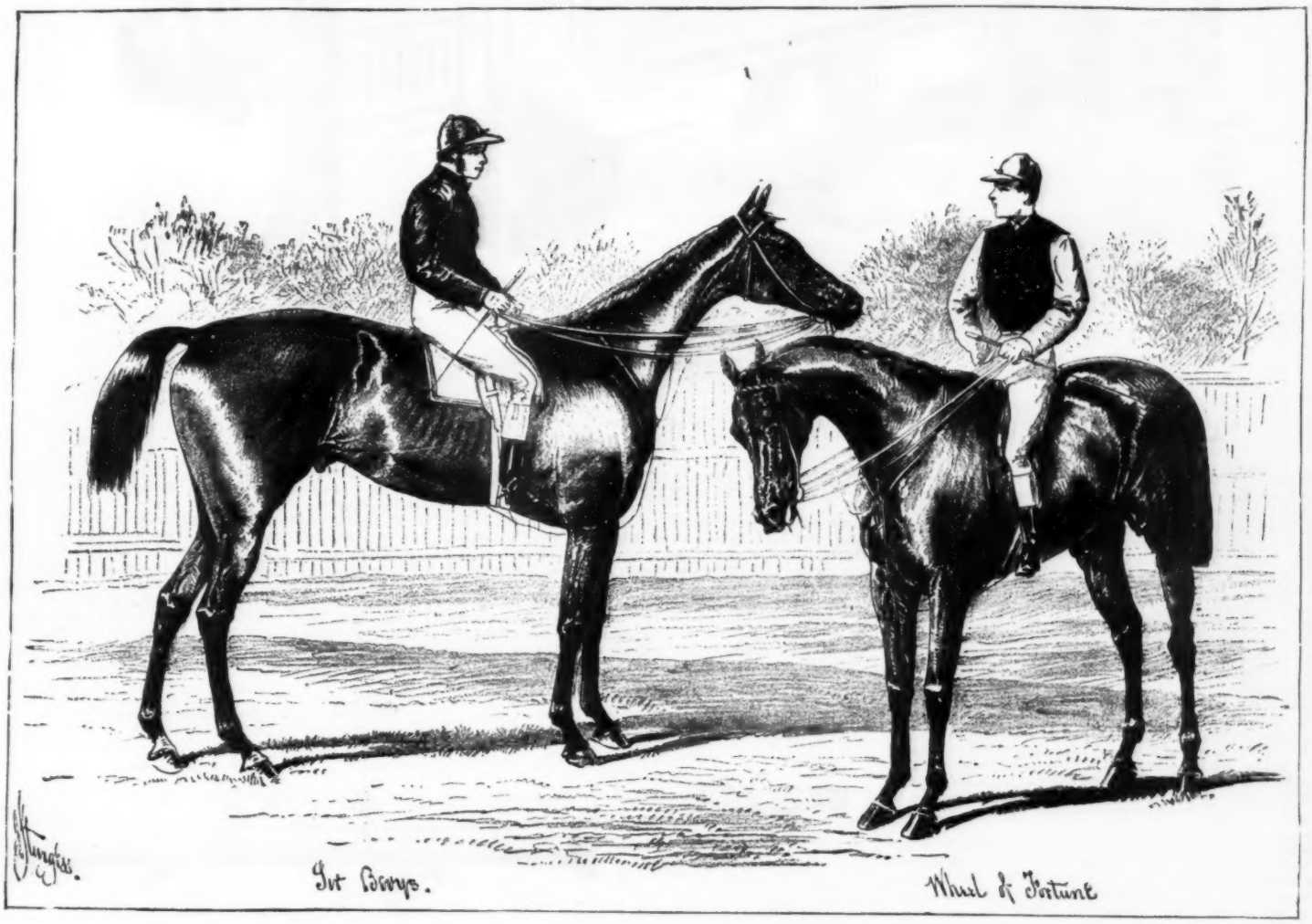
WHEEL OF FORTUNE.

Queen Bertha, who won Lord Falmouth his first Oaks in 1863, has proved a veritable gold mine to the Cornish nobleman. She is the dam of Gertrude, Queen's Messenger, Paladin, Spinaway, and other good animals, and now her union with Adventurer has produced Wheel of Fortune, the best of them all.

The winner of the Oaks is a hard bay, standing, as near as we could guess, not more than fifteen hands two inches, but she is a genuine example of a big one in a small compass, for she has a back and quarters such as are seldom seen in a mare half a hand taller. She has a very pretty head, and good neck running into the best of shoulders, while her legs are clean and free from blemish of any sort. Her record is most brilliant, for, though she has met almost every horse of note of her own age, she has not only never been defeated, but has only once been asked to gallop in earnest.

Lord Falmouth did not introduce her to the public until the Goodwood Meeting, when she took the Richmond Stakes from Peter, Cadogan, and ten others. Then came the Prince of Wales' Stakes at York, in which it was thought that Falmouth fairly extended her, but we have strong doubts upon this point, and a walk over at Doncaster was followed by three victories at Newmarket, the rich Dewhurst Plate being among them.

Her first appearance this season was in the One Thousand, in which she made a sad example of seven opponents, and *National Sports* records how she cantered home for the Oaks. Wheel of Fortune has more valuable engagements than she can possibly meet, but we may see her in the Prince of Wales' Stakes and Coronation Stakes at Ascot, and she is sure to carry Lord Falmouth's first colors in the St. Leger, in which race there is every prospect of her treading in the footsteps of Jannette.—*Ill. London News*, June 7.



SIR BEVYS AND WHEEL OF FORTUNE, WINNERS OF THE DERBY AND THE OAKS.

CAR BUILDING.

AT the recent convention of the Master Car Builders' Association at Chicago, there was a fair attendance—about forty-five—and the meeting was measurably successful in promoting uniformity of sizes, and general improvement in car construction.

The following resume of the proceedings is given in the Chicago *Railway Review:*

Uniformity of freight car construction is not only desirable as promoting convenience—it would result in undoubted economy in expenses and great saving of the lives and limbs of yard and train men.

It is a matter for congratulation that the efforts of five or six years toward the establishment of standard form and proportions of car axles have resulted at last in success. The car builders and mechanics are now in accord, and there is no reason, except the existence of personal crotchets and perversities, why the standard should not become universal as soon as the old axles wear out. The expense and inconvenience resulting from the existing variety of axles have been sufficiently dwelt upon in these columns.

The variety in sizes and styles of draw bars is still greater, and the securing of uniformity correspondingly important. The committee on this subject received some twenty-four answers to the inquiries for information which they sent out. The twenty-four roads used eleven different sizes of draw bars. None claimed any special advantage, though each thought its own "about right." Sixteen different sizes of dead woods were in use on twenty-three roads. If replies had been received from all the roads to whom inquiries were addressed, a corresponding proportion of differences would probably have been shown. This variety entails enormous expense in the repairs of freight cars, rendering it necessary to keep large stocks on hand and delaying repairs (and consequently shipments) to the great loss of the owners.

The detention of time and perishable freights is a strong consideration. The committee recommended standard dimensions of draw bars and their fastenings, and their advice was adopted to a considerable extent. Their idea was, in adopting a standard, to have it of the highest degree of strength. A recommendation to adopt a draw bar spring of greater capacity than those now in use was favorably considered. The majority of those now in use close under a

pressure of 5,000 or 6,000 lb. As a consequence, they are very little protection against shocks and strains. The convention adopted a spring as a standard, having a capacity of 13,000 lb. As will be seen from the report of the proceedings, some progress was made. The importance of impressing the necessity of the greatest possible degree of uniformity upon the general officers of their road was dwelt upon in the report by several speakers.

There certainly should be no hesitation on the part of superior officers in enforcing a plan so manifestly tending toward economy.

Another important report was that relating to the subject of the proper construction of the screws and nuts used in car building. Several different standards are in use, and taps and dies easily get further and further away from the standards. The result is an almost infinite number of sizes. When a foreign car comes in for repairs, it is found often almost impossible to replace properly fitting nuts where that is necessary. Ill fitting nuts and bolts are used, and the consequence is that threads are either broken in screwing or the nut soon works off, when the car goes out on the road. This results in the dropping down of draw beams, draw bars, truck framing, and many other parts, causing accidents which destroy property, delay trains, and endanger life. That this is no imaginary evil, every car builder knows; and yet they have hitherto permitted it to increase instead of ending it as it may be done. One member of the committee which prepared the report exhibited some very striking specimens of lack of fit between bolts and nuts supposed to be of the same size. He also dwelt upon the great waste of iron in making bolt head nuts much larger than was necessary.

This results largely from the fact that the manufacturers of the iron are not held strictly to the size specified. He demonstrated clearly that a saving of from 10 to 40 per cent. could be made in this item by conforming rigidly to the Franklin Institute standard. It is clear, therefore, that the adoption of that standard and the resolution to abide by it, will result, if the members of the association are in earnest, in great saving in time, money, patience, and even life.

Really the most important report of the session was that upon the prevention of accidents to train and yard men. The committee took the wise course of consulting the men themselves who are engaged in these hazardous occupations. They recommended first a uniform height for draw bars. This the association had already fixed at 2 ft. 9 in. from the rail; but it appears that in practice there are variations of 3 inches. This is a constant danger to men engaged in coupling, besides being an evil in a purely economical point of view. The practice of fastening coupling pins so that they could not be withdrawn entirely is a prolific source of accidents. The use of double deadwoods, mankillers, was condemned; and many changes calculated to make the ladders, brake wheels, and running boards more secure, were suggested.

All of these recommendations were adopted, and every disposition was shown to do all that is possible in car construction to render the positions of train men more secure. An effort in this direction was frowned down, because it involved the recommendation of a patent device. Whether such considerations should be allowed so much weight is at least debatable. The interest of humanity is certainly paramount, and anything which will clearly aid it should receive due recognition.

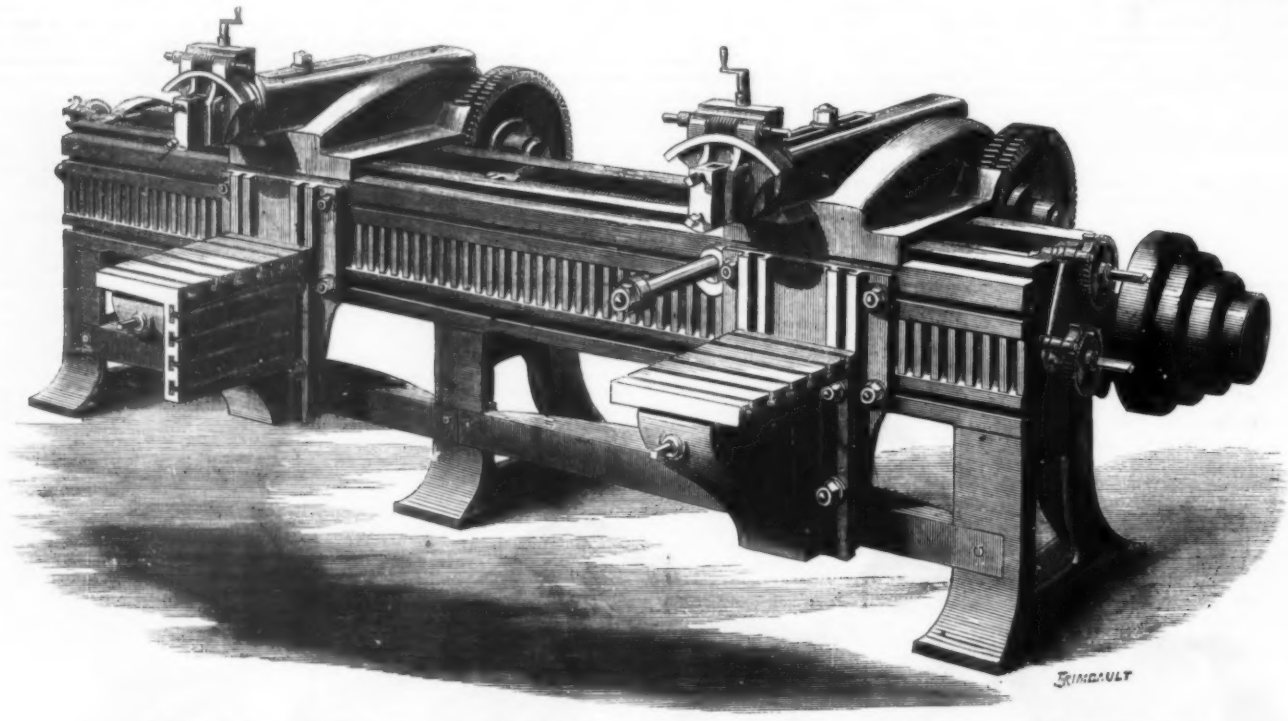
We think that this convention has demonstrated that the Master Car Builders' Association is doing an excellent work. It is advancing the interests of the owners of railways, their employers, and the public. So far from its work being nearly done, it is, hardly begun. It is, of course, to be regretted that every branch of that work is not carried out with the greatest efficiency; but that is not to be expected. All that can reasonably be looked for is a fair degree of real progress, and that is worth all it costs. A good movement is the proposed co-operation with the Western Railroad Association, in the examination of the mechanical merits of patented devices, which took form in a resolution for joint examination of train brakes for freight cars.

Another idea was the appointment of a committee to conduct the conventions by preparing a time programme and enforcing the observance of parliamentary rules. Much time can thus be saved and the general efficiency of the conventions promoted.

IMPROVED SHAPING MACHINE.

WE give a view of a shaping machine with double heads constructed by Sharp, Stewart & Co., of Manchester. The machine has a stroke variable up to 13 in., and a quick return motion. The bed is 12 ft. long, and, as will be seen from our engraving, it carries two heads working independently, and each having a traverse of 4 ft.

The machine is adapted for shaping plane, angular, and curved surfaces, and is self-acting in the horizontal and circular cuts. By the arrangement for circular cutting, articles up to 12 in. in diameter can be shaped. The saddles are adjustable, and the tables vertically, while to insure perfect steadiness of the table when the tool is cutting, the saddles are supported below by a stretcher running from foot to foot. A machine similar to that we illustrate was shown by the makers at the Paris Exhibition last year.—*Engineering.*



IMPROVED SHAPING MACHINE.—SHARP, STEWART & CO., MANCHESTER.

THE CONVERSAZIONE OF THE INSTITUTION OF CIVIL ENGINEERS.

THE annual conversazione of the president of the Institution of Civil Engineers was held, May 26th, in the engineering galleries of the South Kensington Museum, London. Some 1,100 guests accepted President Bateman's invitation.

It will be remembered, says the *Engineer*, that last year the exhibits consisted almost entirely of physical apparatus. The telephone, the microphone, and the phonograph were then in their infancy, and nothing more interesting could have been provided. This year the prominent feature was the electric light, which was exhibited on a scale and in a way nearly unparalleled. Advantage was taken of the opportunity to display various systems of electric lighting in such proximity that something like an estimate might be formed of the apparent worth of each.

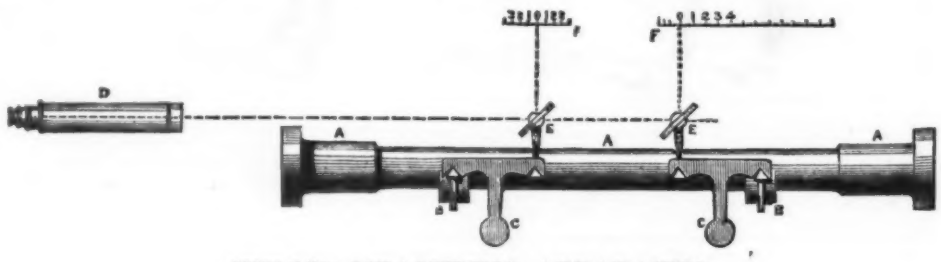
A section of the gallery was fitted up as a tea-room, the long table which ran down one side being lighted by six

HIGGINS' LAMP.

Higgins incandescent lamps, the electricity being supplied by a battery of eight large Bunsen cells outside the building in a shed. The Higgins lamp is exceedingly simple and elegant, and we feel certain that more will be heard of it. In external appearance it resembles an ordinary moderator lamp; indeed, the globes of frosted glass used were actual moderator lamp globes. The lamp is in principle that of Werdermann. The arrangement will be understood at once with the aid of the accompanying diagram. A carbon rod, N C, about ¾ in. in diameter, is held by an arm within the globe. The stand of the lamp hides an iron tube about 1 ft. long, containing mercury, M. Into this is dropped a carbon rod, P C, about ⅛ in. in diameter and 1 ft. long. This rod is floated up by the mercury, its point pressing against the carbon above. The mercury makes the contact, the wires being secured to the base of the lamp by binding screws.

The lamps give each a light of about 150 candles. On Monday night it was extremely soft and steady, but on more than one occasion a lamp became extinguished, apparently without cause, for a few seconds, and then lighted up again. A battery was used solely as a matter of convenience, the exhibitor not having a Gramme or other machine and engine at his disposal.

From the tea-room the south gallery was reached, and this was lighted by a row of six Wilde's lamps, on standards about 9 ft. high. The lights were contained in opal globes, and it is a modification of Jablochkoff's, two carbons standing side by side being used. In all the arrangements in general use for regulating the electric light, the carbon pencils are placed in the same straight line, and end to end. When the light is required, the ends are brought into momentary contact, and are then separated a short distance to enable the arc to form between them.



WILLIS' MEASURING APPARATUS.

To accomplish this object, one of the carbon holders is articulated or hinged to a small base plate of cast iron, which is so constructed as to become an electro-magnet when coiled with a few turns of insulated wire. The carbon holder is made in the form of a right angled lever, to the short horizontal limb of which is fixed an armature placed over the poles of the electro-magnet. When the movable and fixed carbon holders are brought into juxtaposition, and the carbons inserted in them, the upper parts of the two carbons are always in contact when no current is transmitted through them, as shown by the dotted lines in the engraving.

The contact between the carbons is maintained by means of an antagonistic spring inserted in a recess in one of the poles of the electro-magnet, and reacting on the under side of the armature. One extremity of the coil of the electro-magnet is in metallic connection with the base of the carbon holder, while the other extremity of the coil is in connection with the terminal screw at the base of the instrument, from which it is insulated. The coils of the electro-magnet are thus placed in the same circuit as the carbon pencils. When the alternating current from an electro-magnetic induction machine is transmitted through the carbons, the electro-magnet attracts the armature, and separates the upper ends of the carbons, which brings them into their normal position, and the light is immediately produced.

When the circuit is interrupted, the armature is released, the upper ends of the carbons come into contact, and the light is produced as above. When several pairs of carbons are placed in the same circuit, they are by this arrangement lighted simultaneously. The tint of the opal globes was unsatisfactory, and partook a little of the ghastly, a defect which may be easily remedied. The lights burned on the

whole steadily, but there was not that total absence of flicker which is so desirable, and more than once a lamp went out and ignited again automatically. The lamps were of considerable power. We estimated them roughly as giving each about 300 candles.

Next came six Werdermann lamps, on tall stands. These were grouped close to the entrance to the main or central hall, but because the gas engine intended to drive the Gramme machine would not work up to sufficient power, they were not lighted at all. Crossing the central hall, the visitor entered what is known as the "small ship model room." This was lighted by two Serrin lamps, one at each end, suspended from the ceiling, and fitted below with reflectors which threw the light upon the white plaster, from which it was diffused downward. The effect was admirable, and the illumination intensely vivid, without being dazzling to or fatiguing the eyes.

Electricity was supplied for the Wilde lamps by two Wilde electro-magnetic induction machines, while the Serrin lamps were supplied by two A Gramme machines. A Gramme quantity machine was provided to actuate the Werdermann lamps, which, however, were, as we have said, not used. The machines were driven by an 8 horse power Otto silent gas engine. The whole of the apparatus was lent by the British Electric Light Company, and the gas engine by Messrs. Crossley Brothers.

SIEMENS LAMP.

The central hall was lighted by three very powerful Siemens lamps suspended from the roof. These lamps were supplied with electricity by an engine and machine in the Albert Hall, 1,800 yards away, by three distinct leads of wire. A fourth was provided for a purpose which we shall explain presently. The last room of the series was lighted by three Jablochkoff candles, the current being supplied by a six light Gramme dividing machine badly worked by a portable engine. This set of apparatus was lent by the Société Generale d'Electricité, the company which now lights the Thames Embankment.

It will thus be seen that no fewer than five distinct systems of lighting were represented, namely, Higgins', Wilde's, Siemens', Serrin's, and Jablochkoff's, while electricity was supplied by a battery, Wilde's magneto machine, Siemens' machine, and two different Gramme machines, and power was furnished by both gas and steam. We think it may be safely said, that hardly ever had been got together such an exhibition of the electric light in actual operation. As to the results obtained, there can be but one verdict. It was not wholly satisfactory in any case, and in some cases it was very much the reverse.

The Higgins light, as we have said, was excellent, and is beyond question the best table light yet shown publicly in this country, but it is not free from the element of uncertainty; it flickers, and it goes out. The Wilde lamp is more complicated, expensive, and powerful, and is open to precisely the same objection. Of the three Siemens lamps shown, one burnt fairly well; another, the central lamp of the three, was very capricious, and on one occasion dropped a handful of red-hot carbon on a group standing just below it; while the third lamp never remained at the same intensity for ten seconds at a time, sometimes going quite out, then lighting up with dazzling brilliancy, and, after a short and flickering existence, going out again.

The Serrin lamps required constant attention by two trained men to keep them in order. On the whole, nothing was shown which surpassed the Jablochkoff lamps. After the experience of a couple of hours, it was impossible to resist the conclusion that the electric light of the future has yet to be invented, not one of the lamps exhibited possessing the steady or permanent character essentially necessary for domestic purposes, or even for lighting large public buildings. It is difficult to account for the fact that in this country the electric light has not as yet proved nearly so successful as in Paris. The hippodrome there was lighted by electricity, the lamps burning with a steadiness and freedom from flicker which left nothing to be desired. Are we to seek the explanation in the differences in climate or in the attendants?

Of the models and apparatus lent for the purposes of the conversazione, it would be quite impossible to speak in detail, no fewer than 164 distinct exhibits being included in the catalogue.

ELECTRIC MOTORS.

We have stated that four leads were taken by Dr. Siemens from the Albert Hall, three for his own lamps; the fourth was used to illustrate the system which has been so successfully carried out at Sir William Armstrong's private residence, the transmission of power to a distance. If an electro-dynamic machine is supplied with electricity from an external source it will revolve and give out power. The current may be set up by a similar machine a mile away, worked say by a waterwheel. The fourth lead was attached to a small dynamo-machine fitted with a Prony brake in the central hall. In one experiment which we saw carried out with this machine the following result was obtained: The lever of the brake was precisely 18 in. long, corresponding to a circumference of 9·42 ft., the load was 2 lb., and the revolutions 974 per minute. Then

$$\frac{9{\cdot}42 \times 974 \times 2}{33{,}000} = 0{\cdot}55 \text{ horse power.}$$

At the time it was estimated that the machine supplying the current was absorbing 3 horse power, so that the result of the experiment was very unsatisfactory. It must not be taken as a basis, however, for we believe that in some cases Messrs. Siemens have realized as much as 50 per cent. of the motive power. Concerning this question of the transmission of power by electricity, little or nothing is known with certainty. For example, concerning the best proportion between the resistance and the speed, no data have been collected as yet by Messrs. Siemens, and yet the point is one of great importance.

Let us suppose that by increasing the weight carried by the brake in the case we have cited from 2 lb. to 4 lb. the speed had been reduced one-half, then it is clear the power would have remained unaltered, for $9{\cdot}42 \times 487 \times 4 = 9{\cdot}42 \times 974 \times 2$. If now the speed, instead of being halved by doubling the weight, had only been reduced, say to 800 revolutions, there would be an enormous advantage gained. On the other hand, had the weight been halved, then, unless the speed rose to 1,948 revolutions, there must, other things being equal, have been a great loss of useful effect. This path of inquiry cannot long be left untrodden, and may lead to very important results.

THREE-CYLINDER ENGINES.

An improved Brotherhood three-cylinder engine, specially constructed for running with great steadiness at high speeds, was shown in the central hall. This engine is intended to drive two dynamo-machines which are fixed on the same bed plate, the whole being intended to supply electric lights on board Messrs. Siemens Brothers' cable ship Faraday. The wire used for driving the little dynamo-machine whose performance we have just discussed was employed during the evening to impart motion to one of the machines attached to the engine, and thereby to drive it. The engine contains many neat expedients to impart flexibility, reduce friction, and give steadiness.

Mr. Brotherhood prefers that no publicity should be given to these features, which could hardly be made the subject of a patent, and we comply with his desires. It may be mentioned that three-cylinder engines used to propel fish torpedoes weigh 35 lb. only, and indicate 72 horse power, or say 2 horse power for every one pound of engine. They only run for a few seconds, imparting a velocity of 27 knots an hour to a torpedo for 250 yards. They are worked at an air pressure of 600 lb. on the square inch.

Another modification of the multiple cylinder system was exhibited by Mr. Okes, of Cannon street. We illustrate this engine, which is the invention of Messrs. Payton & Holmes, purchased by Mr. Vosper. The inventor uses either two or four cylinders, the four cylinders being placed in pairs at right angles, one crank and eccentric answering for both. Steam is admitted only on the top side of the pistons of one pair of cylinders from the top port, and to the top of the other pair of cylinders from the bottom port. The engines can be reversed by a two-way cock for each pair of cylinders, placed behind the ports, and which, by moving a certain distance, reverses the steam current from the top of one pair of cylinders to the top of the other pair. These engines are well got up. The cranks are of steel, the pistons and connecting rods of gun-metal, and the connecting rod ends and main bearings are, we understand, made of special patent self-lubricating metal that will run without oil or grease of any kind. What the metal is we are quite unable to say. If it is really competent to run without grease on large as well as on small crank pins, then the inventor should lose no time, for his own sake, in making the truth generally known. Engineers much want to get rid of grease and oil.

MEASURING INSTRUMENT.

Professor A. B. W. Kennedy showed a drawing of the 45-ton testing machine at the Engineering Laboratory, University College, Gower street, and certain tested specimens, some made by students. He also exhibited an extremely elegant apparatus for measuring very small extensions, deflections, and compressions, for showing, in fact, how materials behave at such loads as are actually put on them in practice. Two points are marked on the test-bar at any convenient distance apart, and only the extension between these points is measured. Thus are eliminated errors due to the collars of the specimen taking up their bearing, to the extension of the testing machine itself, and so on. By using a purely optical multiplying arrangement, Professor Kennedy avoids the back-lash and other mechanical imperfections which attend the use of rack and pinion gear, and also escapes the difficulty of obtaining always the same pressure which attends the use of graduated wedge pieces. Previously, Professor Kennedy could not put a direct pulling strain on a specimen to illustrate the extension of a bar; but he put in instead, a bit of platinum wire, which he heated by a Bunsen flame. The expansion of the wire caused a difference of reading of 15, 20, 30, and even more divisions of the scale. The scale is marked in $\frac{1}{1000}$ in.—each being in reality about 1-6 in. long—each being subdivided into halves by a shorter mark. By estimation one can read with certainty to $\frac{1}{4000}$ in., and by reasoning to $\frac{1}{12000}$ in. The opposite engraving will make the construction of the apparatus intelligible; A A is the test piece; B B clips on the test piece carrying pins; C C weighted drop pieces forming connecting rods; D a telescope fitted with a cross hair; E E two mirrors turning on axes. These have each a line across them for adjustment. F F are two scales carried on rails on a beam fixed to the roof, so that they can be adjusted to zero for any length of specimen. In looking through the telescope both scales are seen at once reflected in E E, and the figure on each covered by the cross hair, is that which is read off for each strain. If both readings alter, the sum of the change is the extension of the bar. The short scale is for the end of the specimen next the lever of the machine, which should not move sensibly, but which does move small amounts due to the take up of collars, and to differing positions of the steel-yard. The distance from the scales to the mirrors is about 11 ft. The radius of the levers, G G, which cause the partial rotation of the mirrors as the specimen lengthens, is about 1¼ in. with the doubling of the angle caused by reflection; this gives a total magnifying power of about 140 to 1. We have no doubt that this very beautiful instrument will play an important part in future investigations as to the behavior of materials under strain. It was designed by Professor Kennedy's assistant, Mr. R. H. Willis, and made by Messrs. Elliott, Strand.

ASBESTOS PACKING.

The Italo-English Pure Asbestos Company had, in an out-of-the-way corner, one of the most interesting exhibits in the place for engineers. It is well known that asbestos is rapidly growing in favor as a material for making steam-tight joints and packing stuffing boxes. Asbestos is a silicate of magnesia, found in many parts of the world, and, according to a theory now pretty generally received, it is the result of the decay of volcanic matter, and is almost invariably found in volcanic regions. The best comes from Northern Italy. It appears that the Italo-English Company have purchased large mines in North Italy, and have embarked in the manufacture of asbestos goods on a large scale. We trust that the company will steadily maintain the character which it has taken to itself and supply only pure asbestos. Nothing suffers more by adulteration, and nothing, perhaps, which engineers use, is more adulterated than this material. An artificial asbestos is made and mixed with comparatively small quantities of the true material. It is not remarkable that disappointment follows its use. Mr. Allport, representing the company, showed on Monday, among other things, a gland packing from a valve spindle of a French corvette, which packing had been in constant use fifteen months, and was still in excellent condition. Specimens of asbestos "cardboard," and packing rope also shown were of excellent quality. Nothing has retarded the general adoption of asbestos as a packing, we venture to think, but the difficulty which has hitherto been met with in getting it good.

CATCHING RAIN WATER.

A model of a curious device for catching rain for water supply purposes was exhibited by Mr. Ormsby. The inventor excavates to a moderate depth an area of a few acres of land; he divides this space into squares, and constructs on it a series of shallow brick boxes, so to speak, open at the top. The sides of these are each fitted with one of four triangular slate slabs, so that the area covered when finished is filled with square truncated pyramids. These collect the rain, which runs down the sloping slates, and escapes through an aperture at the base or point of each cone into a system of cross drains, which all lead into one, and thence to a covered reservoir. Absorption and evaporation are thus prevented. As a catch water system the arrangement is ingenious.

TESTING MACHINES.

Mr. Carrington exhibited three testing machines, the invention of Mr. V. de Michele, which deserved special notice. The first was an improvement on the well-known Michele cement tester. All the pivots in this machine were made with knife edges, and it is proportioned to give a strain of one ton, which is more than has hitherto been found necessary. It is a noteworthy fact that since the system of testing cements has become common, the quality of Portland cement has been gradually improved, and the best cement made by Messrs. Francis, of Nine Elms, requires a pull of 1,300 lb. to tear asunder a specimen 2·25 square inches in area of cross section, or, say, 577 lb. per square inch. The second instrument is one used at the Bank of England for testing the quality of paper, and is in principle much like the cement tester. The clamp for securing the paper is of peculiar construction, so that no sharp edges shall weaken the specimen. The last of the three machines is a wire tester of simple construction. It consists simply of a clamp, in which one end of a given length of wire can be secured, and of a small winch handle, the end of the axis of which is fitted with a second clamp. The wire to be tested is clamped, and the handle turned, twisting the wire. The spindle of the winch is fitted with a screw which moves a small wheel, carrying a dial on which a pointer tells the number of revolutions which the wire will sustain before it breaks. Mr. Carrington states that this has been found an admirable test of the quality of wire of any material.

EXCELSIOR DISINTEGRATING MIDDLINGS PURIFIER.

THE accompanying engravings show the form and construction of the patented middlings purifier, owned and manufactured by Messrs. Huntley, Holcomb & Heine, of Silver Creek, Chatauqua County, New York. By this machine the dust and fiber are taken from the middlings before they are passed to the sieves for separating them from the coarser particles of bran—a process originating with the patentees above named.

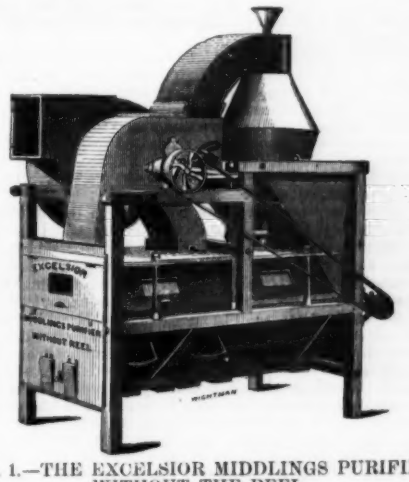


FIG. 1.—THE EXCELSIOR MIDDLINGS PURIFIER WITHOUT THE REEL.

The working of these machines can be explained in few words:

The middlings are fed through the feed hopper and feed tube upon the double disintegrators, L and L 1, within the double hood, B and B 1. By this arrangement an even distribution of the middlings in the current of air is secured, and they are completely freed from flour, fiber, and dust before they pass to the sieves. The middlings, going to the

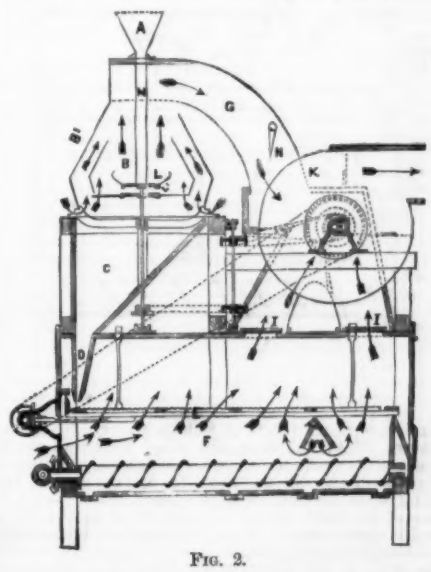


FIG. 2.

sieves in this condition, are distinct and not liable to fill up the meshes; and on being fed to the upper disintegrator are well operated upon; the greater portion of dust and fiber being carried off within the inner hood, and thence down the wind trunk, G.

The middlings now drop upon the lower disintegrator, where they are acted upon in a similar manner, and all the remaining dust and fiber are separated and carried off through the space between the two hoods, and are prevented from mixing with the middlings as they are discharged from or upon the upper disintegrator. By thus dividing the current of air the middlings are acted on with a stronger blast without the drawing of any good stock over into the wind trunk. The current of air taken through the disintegrators is controlled by the valve, N, in the wind trunk, and the

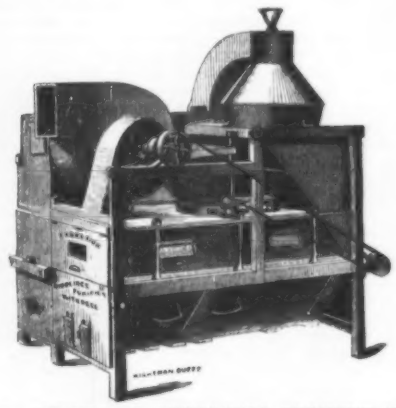


FIG. 3.—EXCELSIOR MIDDLINGS PURIFIER WITH THE REEL.

light impurities are carried thereby into the dust room. In this way the dust is kept out of the mill.

As they leave the disintegrators the middlings drop into the hopper, *e*, and, passing through the spout, are discharged upon the sieves, E, carried upon a reciprocating shaker; the sieves are uniform in size and interchangeable, so that the machine can be adapted to different grindings speedily and without stopping any other part of the machine.

To prevent the bran specks from passing through the sieves, suction is applied to them, controlled by the valves, I I (Fig. 2), the space above the sieves being connected with a fan by an air chamber. The bran passes over the tail of the shaker and is discharged through two pockets at the foot of the machine.

Since dust, speck, and fiber adhere to middlings with great tenacity, this process of subjecting middlings to the percussive action of whippers or beaters while passing through a current of air helps materially to free them from such deteriorating substances, leaving them sharp and distinct and in good condition, to be readily separated from the remaining bran and specks, thus obviating the necessity of complicated traveling air blasts or any of the various brushing devices so destructive to bolt cloth.

To save the waste of flour adhering to the middlings, Messrs. Huntley, Holcomb & Heine have devised for their larger machines a flour-saving air chest and reel, making the machine shown in Figs. 3 and 4. In this machine the air separation, with the material whipped from the middlings by the disintegrators, is drawn by the suction of the fan down the wind-trunk, G, into the air chest, H. The check boards of the air chest form eddies, and, by retarding the outward current, allow the flour and heavier particles of the air separation to settle in the hopper-shaped bottom of the air chest. Here is placed a conveyor which delivers the heavy separation through a spout to the head of the reel, J,

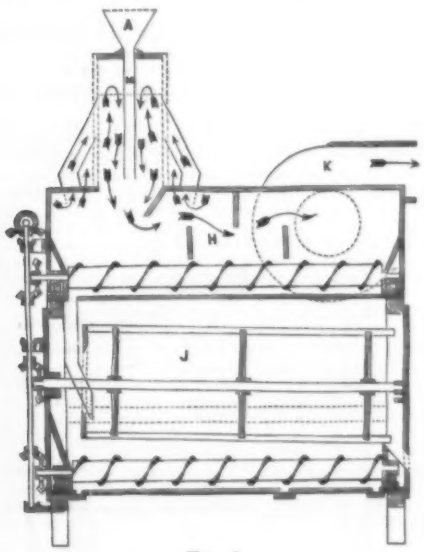


FIG. 4.

which is covered with cloth of suitable fineness to bolt out the flour. While the fiber and other impurities are discharged at the tail of the reel, the lighter impurities are blown out of the fan mouths. To prevent the reel from clogging it is provided with a rapper, which keeps the meshes of the cloth open. The amount of flour saved by the reel is considerable. If the grinding and the quality of the middlings are right the saved flour is fit to be returned to the bolt; at the worst, it will make a good low-grade flour.

These machines are manufactured under undisputed patents, and are now sold at prices varying, according to size, from $150 to $400, without reel, and from $250 to $500, with reel.

The same firm manufacture also the excelsior bran duster for removing flour from middlings previous to their passage to the purifiers. Both the duster and purifiers require but little power, and do their work economically and efficiently.

CORK AND CORKS.

By H. G. GLASSPOOLE.

OF all the various productions of the vegetable kingdom which man appropriates to his own use and convenience there is hardly one so universal as the bark from the cork tree, for not only is it employed in the arts and manufactures, but articles for domestic purposes, such as stoppers to bottles, etc., are to be found in all parts of civilized countries. The trees from which this substance is obtained are a species of oak, *Quercus suber*, and its variety, *Q. occidentalis*, the first of which grows plentifully in the south of France, Spain, Algeria, and in some parts of Italy; the second is a native of the Atlantic side of France and Portugal, where this tree grows to the greatest perfection, and from which country we are indebted for the major part of our supply.

The cork tree bears a general resemblance to the broad leaved kind of *Q. ilex*, or evergreen oak, of which species some authors consider it only a variety, but when full grown it forms a much handsomer tree. The wood of the cork tree is of little value for constructive purposes, as it is liable to decay, and it also is said to contain an acid which destroys nails driven into it, but it makes an excellent fuel in the countries where it is grown. The value of the bark fully compensates for the inferiority of the wood. When the tree has arrived at a certain state of maturity, or twenty years—some say earlier—it periodically throws off its bark after it has grown a prodigious thickness and begins to clothe itself with a new one. The bark thus cast off is very indifferent and of little commercial value; to prevent this the tree is not allowed to have its own way, but the bark is artificially removed by the following process:

In the months of July and August, when the sap flows plentifully, a circular incision is first made a few inches above the surface of the ground, then a similar circular cut round the trunk immediately under the main branches, care being taken not to penetrate the inner bark. The portion intervening between the two cuts is then slit down longitudinally in three or four places, which divides the bark into broad sheets or planks. The tree is now left for a time so that the moisture from the sap may dry. The bark is then removed from the stem, more or less curved according to the breadth and diameter of the trees from which it has been taken. The instrument used for cutting and removing the bark from the stem is a sort of ax, the handle of which is flattened into a wedge-like shape at the extremity, which serves to raise the bark. This ax is not unlike that used in Britain for taking off the bark from the common oak. The bark grows again, and as this tree exists, according to Dr. Hamel, a hundred and fifty years or more, its disbarking takes place regularly every eight, nine, or ten years, the quality of the bark improving with the increasing age of the tree, which is not in the slightest degree injured by the process. At the first and second gathering the bark is only fit for floats for fishermen's nets and other inferior uses; it is not until the third disbarking that the substance has attained the desired perfection for the manufacture of corks. These sheets, layers, or tables of cork, as they are called, are now scraped on the outer surface to remove the coarser parts of the epidermis and any epiphytes or other extraneous substance. They are then thrown into deep pits and covered with water to soften them in order to be flattened by pressure under heavy stones, after which they are dried over a fire, being frequently turned during the process to prevent returning to their original shape.

There is also another method by which the most pressure in pits is dispensed with, and the bark is drawn flat by the sheets having their convex side placed toward the fire. In time they are considerably charred by the heat; they are then turned and charred on the other side, though in a less degree. The charring gives the material what the cork-cutters call nerve, and has also the effect of closing the pores of the oak, which otherwise would absorb moisture and render it useless for the purpose of stoppers, bungs, etc. Too much burning destroys its elasticity, but if not sufficiently burnt it will not be firm enough for the operations of the cork-cutter's knife. The bark now undergoes a rough cleansing; it is then built up into large stacks until it is bought for exportation by the cork merchants and dealers.

The manufacture of corks into stoppers is thus described: The cork, after being pressed into square pieces, is received by the cork-cutters, and if not sufficiently flat for their purpose they lay it again over the fire in their "burning yard," turning the convex part to the flame; the heat, by twisting the edges of the bark, counteracts the natural bend and flattens it out. During this operation, attention is paid to smoothing it and covering its defects with clay, soot, etc. It is next cut into slips by means of a gauge set, narrow or wide, according to the size of the intended cork, bung, or tap, as the varieties are called, the last being used for stopping the tap-holes of barrels. These slips are again cut into squares of the required length. This operation is performed by one man, from whom they are handed forward to several others. The corks are further divided, according to their lengths, into short, long, and full long. The cork maker is seated before the table or plank, on which is fastened a board about 3 inches thick, 4 broad, and 12 long; immediately on a line with his left hand is a piece of wood rising about 4 inches from the board, and fixed about the middle, on which the cork is laid after being cut as above. This wood not only supports the cork and serves as a guide to the workman, but by its elevation above the board gives room for the knife to cut a part of the cork in a smooth and circular manner without striking the table below. The piece is then turned to the point where the last cut ended, and this is continued until the knife has gone completely round; the top and bottom are then pared level, and the cork is thrown into a box or basket with others of the same length. As the bark is not of the same quality throughout each piece, corks are sorted into superfine, fine, common, and coarse (*vide* Tomlinson's "Cyclopædia of Useful Arts," etc.). Of late years, however, corks have been made in vast number by a machine of American invention, with which a man will make more in a day than he would by hand in twenty days. The hand-made corks, however, are the best. The manufacture of bottle corks is a considerable source of wealth in the province of Gironde, which produces annually about 125,000 quintals of cork. In the district of Catalonia the annual manufacture of bottle corks, as stated by MacCulloch, varies from 15,000 to 20,000 bales, containing 25,000 to 30,000 corks each. The principal provinces in Portugal from which we receive our largest supply are Alemtejo and Algarva, from whence it is generally imported as dunnage in ships laden with wine. The best white cork is grown in France. There are large forests of cork in the French colony of Algeria, particularly on an estate granted some time back by the Emperor Napoleon III. to M. le duc de Montebello. The cork tree has been introduced successfully in the Southern States of America, and might probably be grown there with profit.

The British import duty on manufactured cork was abolished in the year 1845, and in 1860 the duties on cork ready made and cork squared for rounding, which had been fixed in 1853 at 6d. per pound and 8s. per cwt. respectively, were repealed.

The imports of cork into the United Kingdom in 1876 were:

Cork Unmanufactured.	Tons.	Value.
From Portugal	6,267	£172,666
From Spain	395	11,413
From Algeria	351	7,045
Other countries	195	6,391
Total	7,208	£197,515

Cork Manufactured.	Pounds.	Value.
From France	3,174,431	£267,624
From Portugal	2,537,175	147,975
From Spain	927,793	72,354
Other countries	21,804	1,586
Total	6,661,203	£489,539

Ancient Use of Corks, etc.—The cork tree, and the application of its bark to useful purposes, was well known to the Egyptians, Greeks, and Romans. The former used to construct their coffins of this material. Theophrastus, the Greek philosopher, who wrote on botany, etc., four centuries B.C., mentions this tree among the oaks, under the name of *phellus*, and says it has a thick fleshy bark, which must be stripped off every three years to prevent it from perishing. He adds that it was so light as never to sink in water, and on that account might be used for many purposes. Pliny describes the tree under the name of *suber*, and relates everything said by Theophrastus of *phellus*. From his account we learn that the Roman fishermen used it as floats to their nets and fishing tackle, and as buoys to their anchors. The use of these buoys in saving life appears to have been well known to the ancients, for Lucian (Epist. 1, 17) mentions that when two men, one of whom had fallen into the sea, and another who jumped after to afford him assistance, both were saved by means of an anchor buoy. The use of this substance in assisting swimmers was not unknown to the Romans. By Plutarchus, in "Vita Camilli," we are told that of the imperial city was besieged by the Gauls, Camillus sent a Roman to the Capitol, who, to avoid the enemy, swam the Tiber with corks under him, his clothes being bound upon his head, and was fortunate enough to succeed in the attempt. The use of cork for stoppers was entirely unknown to the Romans, and instances of its being thus employed may be seen in Cato's "De Re Rustica," cap. 120; but its application to this purpose seems not to have been very common, or cork-stoppers would have been oftener mentioned by authors who have written on agriculture and cookery, and also in the works of ancient poets. The convivial customs of those days had no connection with the bottle, glass bottles being of a much later invention. Instead of having dozens of sparkling champagne or hock, to be liberated from the bottle by the corkscrew, at their feasts, the guests filled their drinking cups of gold, silver, crystal, or beechwood from a two-handled amphora, a kind of earthenware pitcher in which their choice wines used to be kept. The mouths of these vessels were stopped with wood, and covered with a mastic, composed of pitch, chalk, and oil, to prevent air spoiling the wine or evaporation taking place. Columella, who wrote one of the earliest works on agriculture, gives directions for preparing this cement. Pliny, in describing the cork tree, says it is smaller than the oak, and its acorns are of the very worst quality. He tells us the cork tree did not grow throughout Italy, and in no part whatever of Gaul. At the present day it is abundant in France, and Fee states that the acorns of *Q. suber* are of an agreeable flavor, and the hams of Bayonne are said to owe their high reputation from the pigs having fed on the acorns of the cork tree. Some ancient authors speak of the cork tree as the female of the holm oak (*Q. ilex*), and in countries where the holm does not grow they used to substitute the wood of the cork tree, more particularly in cartwrights' works in the neighborhood of Lacedæmon, etc.

The employment of cork for stoppers of bottles appears to have come into use about the seventeenth century, when glass bottles, of which no mention is made before the fifteenth century, began to be generally introduced. Before that period apothecaries used stoppers of wax, which were not only much more expensive, but far more troublesome.

In 1553, when C. Stephanus wrote his "Prædium Rusticum," cork stoppers appear to have been very little known in France, for he states that this material was used principally for soles in that country. Another author, writing about the same time, tells us that thin glass flasks, covered with rushes and straw and with tin mouths, which could be stopped sufficiently close without a cork, were used by the higher classes of that period.

We do not know when cork and corks began to be generally used in this country, but I find in that very amusing and instructive diary of Mr. Samuel Pepys the following entry: 14 July, 1666, he states, after having written to the Duke of York for money for the fleet, he went down Thames street, and there agreed for four or five tons of cork to be sent to the fleet, being a new device to make barricados with instead of junts (old cable)—but he does not inform us how the device answered. In Evelyn's time (1664) cork was much used by old persons for linings to the soles of their shoes, whence the German name for it, "pantoffelholtz," or slipper wood. The Venetian dames, Evelyn says, used it for their choppings, or high-heeled shoes, to make them appear taller than nature intended they should be. The poor in Spain lay planks of cork by their bedside to tread on instead of carpets. Sometimes they line the inside of their houses, built with stone, with this bark, which renders them very warm, and corrects the moisture of the air. Loudon relates that in the celebrated convent at Cintra (Portugal) several articles of furniture are made of this tree, which strangers who visit the convent are requested to lift in order that surprise may be excited at their extraordinary lightness. The various uses for the common purposes of every-day life to which this substance is applied are well known. Burnt cork supplies our artists and colormen with Spanish black. It is largely used for lifeboats, for stuffing life-belts, mattresses, etc., to be used at sea in the preservation of life.

Virgin cork, or the outer bark of this tree, is now very much used for window flower boxes, grottoes, etc. Very thin sections of cork are employed in the manufactory of hats; these sections are cut by steam machinery 50 to 120 plates to the inch. The shreds and parings of this substance are not wasted, but being ground into powder and mixed with melted India-rubber form the basis of many floor coverings, such as kamptulicon—the soft unresounding material which covers the floor of the reading-room of the British Museum, the floors of the Houses of Parliament, and various other public and private institutions, to prevent the noise occasioned by footsteps, etc.

Cork was formerly employed in medicine even as far back as the time of Pliny, as he tells us that the bark of the cork tree, pulverized and taken in warm water, arrests hæmorrhage at the mouth and nostrils, and the ashes of it taken in warm wine are highly extolled as a cure for spitting blood. (See Plin., "Nat. Hist.," b. 124.) In more modern time powdered cork has been applied as a styptic, and hung about the necks of nurses; it was thought to possess the power of stopping the secretion of milk. Burnt cork mixed with sugar of lead and lard has been used as an application to piles. (See Pereira's "Materia Medica.")

When rasped or powdered cork is subjected to chemical solvents, such as alcohol, etc., it leaves 70 per cent. of an insoluble substance called suberine. This, treated with nitric acid, yields the following products: White fibrous matter 0·18, resin 14·72, oxalic acid 16·00, suberic acid (peculiar acid of cork) 14·2, in 100 parts.

Cork contains tannic acid, which makes it an improper substance for closing vessels containing chalybeate liquids, as the iron is in part absorbed by the cork and blackens it by forming in its substance tannate of iron. The whole of the water may thus become discolored.

Cork is a nitrogenous substance, which, next to cellulose, is the most important constituent of the cell wall. Cellulose, corky substance, and fatty matters seem to be found in the same cell, and when the cellulose has been absorbed, the corky substance alone remains. It forms the outermost part of the cell wall, and unites the cells together. (See Balfour's "Class Book of Botany.")

The bark of many trees resembles cork. There is a variety of *Ulmus campestris suberosa*, the cork-bark elm, which grows in our hedgerows, whose bark assumes something of the external appearance of cork in its softness and elasticity, as well as in its chemical properties; but as it does not grow to any great thickness, it is not of any value for economic purposes.

The cork tree, *Q. suber*, and its varieties, are to be found growing in many of the botanical, horticultural, and private gardens of England. It was introduced in or before 1699 by the Duchess of Beaufort, and is readily propagated by acorns.

In "Notes and Queries," series 4, vol. v., it is stated that in some parts of Lincolnshire it is believed that cork has the power of keeping off cramp. It is placed between the bed and mattress, or even between the sheets. Cork garters are made by sewing together a series of thin disks of this material between two silk ribbons and worn for the same purpose.

Where the bark of *Quercus suber* cannot be obtained many substances have been found to supply its place among the spongy bark or wood substances of other trees. The wood of *Anona palustris*, growing in the West Indies, called the alligator's apple, is of such a soft nature that it is frequently used by the negroes, instead of corks, to stop their jugs and calabashes.

The word cork is said to be derived from the Spanish *corcho*, from the Latin *cortex*.—*Pharmaceutical Journal.*

WEIGHTING WHITE SILKS.

By M. MARIUS MOYRET.

AT first sight it might appear that articles of white silk must be, as regards weighting, like Cæsar's wife, above all suspicion. It is nothing of the sort. Chemists are ingenious, and little by little they have arrived at results which, without equaling the height reached in the other branches, threaten much for the future.

The most ancient method of loading whites consists in the use of refined starch-sugar, or of cane-sugar. By taking silks through a solution of sugar, they gain about fifteen per cent. in weight. This operation is done last, and the silks are dried out of the sugar, after having been well squeezed and whizzed. This process cannot be accused of injuring the strength of the silk, but, instead, it yields goods clammy to the touch, and dreading rain-spots more than pure silks. In damp weather they absorb moisture, and attract flies to some extent, if there are any. It is true that by impregnating the solution of sugar with quassia, they may be made to do duty as fly-papers—a compensation not to be disdained. You see how the progress of science has succeeded in creating a new "mission" for ladies. If dressed in white silks, weighted with sugar, and seasoned with quassia, they aid in ridding the world of insect pests.

In these latter days sugar has found a rival in glycerine. By degrees is has been rendered colorless, and freed from its primitive odor, too strongly suggestive of a tallow candle. It is used in the same manner as sugar, and is open to the same inconvenience. The use of deliquescent salts, such as the chloride of magnesium, enables the silks to remain somewhat damp even in the driest weather, and is thus a fresh means of gaining a few per cents.

This method of loading whites isused for all kinds. When applied to raw silks it is clear gain; and in cases of un gummed silks it compensates for a part of the loss sustained in that process.

Latterly much use has been made of a weighting known as X, which we are now about to examine. At the outset, say ten years ago, the X weighting was applied by taking the silks through a very strong solution of perchloride of tin, rinsing in abundance of water, and soaping at a boil. The weight taken up may be twenty per cent. We may here remember that "appetite grows by what it feeds on;" and it became customary to take the silk *twice* through the tin solution, the first time while still in its raw state. The soaping process fixed the tin at the same time as it ungummed the silk. The first tin bath made up for the loss sustained in soaping, and the second was clear gain. A third tin bath was even tried, but in this case the silk was too much injured. A further step was substituting pink-salt (double chloride of tin and ammonium) for common perchloride of tin, as it was less hurtful to the hands of the workpeople.

The weighting X has had only a moderate success; it is still practiced, but only to a limited extent. In fact, the silk gains weight, but it does not increase in bulk to a corresponding degree. The oxide of tin fixed on the fiber is very dense, and this is precisely what is not wanted. The manufactured goods thus weighted rapidly lose their qualities, and soon they are only valuable as ores of tin, being very rich in that metal.

We are now about to enter into some dry calculations as to how the weighting is reckoned, and how it ought to be reckoned, and upon what basis the dyed silks of the present day ought to be sold.

A manufacturer sends a quantity of silk to the dyer to be weighted black. Let us take 100 lb. sent to the dyer. If he does not return 100 lb. it is said that the silk has lost in dyeing; if he returns more than 100 lb. it is said to have gained, and the mere increase is taken into account. Thus, if the dyer sends back 125 lb. it is said to have gained 25 per cent. Thus, the original weight of the silk before dyeing is taken as the basis; anything less is considered as a loss, and anything above is regarded as gain. At first glance this may seem just and rational, but it is by no means so from the dyer's point of view. Let us suppose that a dyer has received 100 lb. of raw silk and sent back 150 lb. This, according to the above way of looking at the transaction, is a weighting of 50 per cent., and is called a "half-heavy," and considered a moderate, and, if you will, an honest weighting. But an experienced buyer will not share this opinion, and he will tell you that this 50 per cent. is in reality 100 per cent., sold under false pretenses.

What does it matter to the buyer that 100 lb. have been sent to the buyer? What concerns him is what remains of it after soaping. If we admit a medium loss of 25 per cent. in ungumming, then of the original 100 lb. of raw silk there will remain only 75 lb., and if the lot is then weighted up to 150 lb., the addition is, of course, cent per cent.—*Moniteur des Soies.*

CHROME-BLACKS UPON WOOL.

THE following paper was read before the German Chemical Society, Berlin, by Dr. M. Reimann, editor of the *Farber Zeitung:*

For a considerable time chrome-black has been employed as the cheapest black in woolen dyeing. For this purpose the wool was first boiled in a weak solution of bichromate of potash (the substance known in many English dyehouses simply as "chrome"), along with some sulphuric acid, so much of the latter being used that a portion of the bichromate only gives up free chromic acid, and the wool is then dyed in a logwood-beck. The above preparation has since been modified by the addition of argol, and subsequently of blue-stone. When the wool was boiled with the bichromate and sulphuric acid alone, a certain quantity of chrome-alum was formed, whilst the oxygen thus liberated seized upon the wool and gave it a hard feel. A part, however, of the chromic acid liberated remained upon the fiber, and subsequently converted the chromogen of the logwood into the true coloring matter, hematine. This chromic acid, adhering to the fiber, was apt, in case of unskilfull management, to be deposited irregularly on the wool, which then became irregularly dyed. The bath in which the wool has thus been boiled retains afterwards a yellow color, in proof that it contains free chromic acid. [Cannot undecomposed bichromate of potash produce also a yellow color, even if no free chromic acid is present?] If argol is added, the chromic acid, as fast as liberated, is reduced at the cost of the former substance to chromic oxide, and both the bath and the prepared wool have in this case a greenish color. The argol which escapes decomposition by the chromic acid plays the same part with the chrome-alum generated as is done in other cases by a mixture of argol and aluminous alum. Still a little free chromic acid must remain upon the fiber if a true black is to be formed. If blue-stone is superadded to the above ingredients, it acts also as an oxidizing agent in the same manner as chromic acid, whilst at the same time the oxide of copper produces, with the coloring matters of the logwood, a blue compound, which imparts to the black a bluish reflection.

An attempt has lately been made to get up chrome-blacks by boiling the wool with a mixture of chrome-alum and argol, and dyeing afterwards with logwood. [It will be distinctly borne in mind that chrome-alum is not a mixture of chrome and alum, but a definite compound, in which chromic oxide takes the place which in common alum is occupied by alumina.] This attempt was founded on the expectation that in presence of argol the chromic oxide would fix itself upon the fiber, just as does the alumina of common alum under similar circumstances. This accordingly took place, but as no oxidizing agent was present the result was not a black but a slate gray. As soon as any oxidizing agent is added a black is produced, and not only when the wool is first prepared and then dyed, but when it is treated at once with chrome-alum, argol, and decoction of logwood. As an oxidizing agent, bichrome and sulphuric acid were first used, and subsequently blue-stone.

From the above we may draw the practical conclusion that for the bichromate of potash hitherto employed, chrome-alum may in part at least be substituted. This is of the more importance, as chrome-alum has been hitherto a troublesome by-product of various chemical operations, and has hitherto been difficult of disposal. It is not even necessary to use crystalline chrome alum, but its solutions, as obtained in certain chemical works, may be employed in proportion to the solid matter they contain.

It is well known that salts of iron, especially copperas, along with argol and blue-stone, subsequently followed up with logwood, give a good black upon wool—the so-called Sedan black. The suggestion was therefore natural to combine the action of chrome-alum with that of the salts of iron. On the one hand, we thus obtain the needful oxidizing agent, and can use the cheap chrome-alum without further addition; on the other hand, the black compound formed by logwood with the oxide of iron contributes much to the depth of the color. This expectation was verified on actual trial.

Wool boiled with a mixture of iron-alum, chrome-alum, and argol, and dyed up with logwood, took a good black. A similar result was obtained by boiling the wool in a beck containing the above salts along with the necessary quantity of alum. As iron-alum, as soon as a demand for it appears, can be produced at a very low figure, this method of obtaining chrome blacks offers a pecuniary advantage. As only neutral salts are present in the bath, and as especially there is no free sulphuric acid present, the wool retains its softness, which in the ordinary method of obtaining chrome-black is to a great extent sacrificed.

Chrome-black, as well as iron-black, has its good and its bad properties. Among the virtues of chrome-black we may reckon its resistance to acids; its defects are its unpleasant tendency to turn green on exposure to air and light, its feeble permanence in contact with alkalies, and the harsh feel of the wool. Iron-blacks have not these defects, but they do not bear acids. If we combine chrome-black and iron-black as above, we obtain a black which bears fulling, is not turned green by light and air, does not harden the wool, and resists sulphurous acid.

The general introduction of this process would enable chemical works to dispose of usefully what is now a troublesome residue.—*Chemical Review.*

IMPROVEMENTS IN COATING MIRRORS.

THE French Academy has awarded a prize of 2,500 francs to M. Lenoir for improvements which secure to mirrors all the advantages of silvering, together with the qualities of amalgamation under conditions which preserve workmen from exposure to mercurial vapor. The glass, after being silvered by means of tartaric acid and ammoniacal nitrate of silver, is exposed to the action of a weak solution of double cyanide of mercury and potassium; there is thus formed a white and brilliant silver amalgam which adheres strongly to the glass. The operation is facilitated, and all the materials are economized, by sprinkling the glass at the moment when it is covered by the mercurial solution, with a very fine zinc powder, which precipitates the mercury and regulates the amalgamation. Mirrors which are thus prepared are free from the yellowish tin of ordinary silvered glass, and the amalgam is not easily affected by sulphurous emanations. The committee, in their report, also recount M. Lenoir's improvements in galvano-plastic processes, his discovery of an autographic telegraph, which reproduces writings or drawings with printer's ink, his new and ingenious methods for securing the synchronism of the transmitter and the receiver, and the well-merited reputation which he has acquired from his gas motor.—*Comptes Rendus.*

COLORED PENCILS.

L. VON FABER makes pencils for writing upon glass, porcelain, metal, etc., as follows—Black: ten parts of lampblack, forty parts white wax, ten parts tallow. White: forty parts white lead, twenty parts wax, ten parts tallow. Blue: ten parts Berlin blue, twenty parts wax, ten parts tallow. Dark blue: fifteen parts Berlin blue, five parts gum Arabic, ten parts tallow. Yellow: ten parts chrome yellow, twenty parts wax, ten parts tallow.—*Dingler's Journal.*

COLORED PHOTOGRAPHS.

M. CROS prepares three photographic impressions of any object by sifting the light through solutions which will respectively arrest the green rays, the yellow rays, and the violet rays. The impression from which the green has been excluded, if developed under green light, will appear intensely green at points where the original was the greenest, and pale green or black at the green points where the green was mingled with other colors or was entirely absent. By combining the three negatives, and superposing the images by the help of reflecting prisms, he obtains an approximate solution of the fixation of colors by photography.—*La Nature.*

REFRACTION OF DARK HEAT.

By P. DESAINS.

THE author has never met lenses so constructed as to collect to the same focus rays both from the beginning and the end of the dark spectrum. The study of the cold rays of the dark spectrum may lead to rules for constructing such lenses. If it is possible in the dark spectra to follow and recognize one and the same group of rays, then, in spite of the differences between the refractive and dispersive powers of the substances used, the absolute value of the refractions experienced by dark rays of one and the same wave lengths in different diathermanous bodies may be determined.

THEORY OF THE TELEPHONE.

THE telephone, which was so easily explained in the beginning, is enveloped in difficulties, and requires to be studied attentively. The iron plate vibrating under the influence of the voice in the transmitter, and subject to the action of the magnet in the receiver, was regarded as indispensable. We know now that it is possible to replace it in the receiver by non-magnetic substances, by a plate of copper, of glass, of wood, and even of card-board. It was believed then that the magnet exercises a particular action upon the bodies.

We have been mistaken, not in the fact, but in its cause, and if the glass, the wood, and other substances not magnetic transmit the sound, it is because the wood which surrounds and contains the magnet receives the molecular vibrations which are there produced, and communicates them to the substances which are applied to them.

To prove this fact, I availed myself of a microphone as a transmitter, and of a metronome, of which the strokes were regular and uniform and liable to little deviation, while you could study the conditions which gave more or less intensity in the receiving telephone.

It was possible to separate the mouthpiece of the telephone and the diaphragm of iron, and replace it by a glass plate. If you then applied the ear, after having well appreciated the intensity of the strokes which were heard, and raised it little by little to one side only, keeping the other side of the telephone supported, so that the distance could be measured, the intensity underneath diminished hardly any, and when it was placed at a right angle to the side of the instrument, the strokes had nearly the same force; but when you separated the wood a little, the sound stopped, and it was necessary to conclude that the case of the telephone even transmitted vibrations, for as soon as the edge of the glass came to be touched the strokes of the metronome were heard.

You hear equally well by applying the ear to the extremity of a thin glass plate of twenty-five centimeters, the other end of which rested on the side of the telephone. The same experiments have been made with plates of copper, of wood, and of cardboard, the differences in the intensity of the sounds noticed being only due to the greater or less facility with which bodies of different natures receive and transmit vibrations. With a plate of iron, the strokes transmitted are much stronger, and have a particular sound which diminishes rapidly in proportion as you raise the plate; and it is easy to understand that it is the influence of the magnet which is thus enfeebled, while the effect of the molecular vibrations of the case keeps up and causes it to be heard, as in the case of plates which were not magnetic.

It must be inferred, then, that in a telephone receiver the iron diaphragm is subjected to a double influence: that of the magnet and the case in which it is fixed, and as a practi-

cal consequence it is shown that in the construction of a telephone the choice of the case and the manner in which the magnet is fixed are not indifferent matters.

These facts confirm the opinion of Du Moncel, who attributes the effects of the telephone to molecular vibrations of the magnet, and the iron diaphragm only strengthens the vibrations and renders them more sensible to the ear in vibrating itself. The same causes act also in the transmitting telephone, but in an inverse sense; that is to say, the molecular vibrations excited in the case are transmitted to the magnet, and produce in the magnetism of the bar modifications which are transferred by induction currents to the coil. We may say, also, that the vibrations of the case are transmitted directly to the coil in the presence of a magnet producing the induction currents. This manner of regarding it will conform more to what is known of the origin of indirect currents.

Whatever conclusions may be drawn from the facts, the following can be used in the argument: By raising the mouthpiece, and the iron diaphragm of the telephone, and holding it firmly in the one hand, and with the other drawing a violin bow lightly upon the edge, you obtain a sharp sound that can be heard clearly in the receiving telephone. A small ruler placed crosswise before the instrument, and passing beyond it some centimeters, produces a sound when struck at the end with the bow, so that when it is shortened the sounds are elevated and give those of an ascending gamut, which immediately came to the ear at the receiver. What is surprising in this experiment is that the grave notes, which shake the instrument and the hand, are not heard in the receiver, while the sharp notes are reproduced there easily, and the reason perhaps is because the vibrations from the sharp sounds approach to the character of molecular vibrations. It is perhaps needless to say that with an iron diaphragm these facts assume an entirely different character. It has already been demonstrated that the strokes made on the magnet, the coil, or the case, were heard in the receiver. The molecular shock which sufficed for the telephone receiver is too feeble to cause the transmitter to speak. Besides, it may be said that the iron diaphragm, vibrating by speech, exercises a double influence, and that to the magnetic effects in the bar may be added the vibrations which it directly transmits to the case.

The effects from the telephone are too usually attributed to the sensible vibrations of the iron plate moving backward and forward from the magnet, representing the well known and habitually accepted action; but the molecular vibrations which are performed, so to speak, atom by atom in the immovable plate, play a more important part, and without them articulated speech would be impossible.

The telephone and, above all, the microphone, prove to us by surprising phenomena just how far the division and reciprocity of forces may go. But what is still more admirable than these new and marvelous instruments is the old and incomparable delicacy of the ear, which perceives and appreciates, without allowing to escape from it a single one of the thousands of movements which lose themselves in some manner in the infinitely little.—*Les Mondes.*

THE ELECTRIC LIGHT.

By J. JAMIN.

THE burner submitted to the Academy with its points downwards has considerable advantages; such as simplicity, since it requires no mechanism and requires no preliminary preparation, beyond a support and the coke points: mechanical economy, since the number of flames is almost doubled; augmentation of light, since each of the new foci is almost twice as powerful as those of the old construction; quality of the light, which is whiter; more advantageous arrangement of the foci, which direct their greatest quantity of light downwards, where it is wanted, instead of up into the air, where it is useless; and, lastly, economy of combustible material.

ELECTRIC INSCRIPTION OF WORDS.

By M. BOUDET DE PARIS.

THE transmitting apparatus is a microphonic speaker, the carbons of which, instead of being pressed by a spring, are simply maintained in contact by the pressure of a small piece of paper folded in form of a V. The vibrations of the diaphragm of the receiving apparatus cannot be written, since the movements of the style, however delicate the apparatus, can scarcely be distinguished upon the lamp-black. To enlarge the magnetic vibrations of the receiver the cover and the diaphragm of a Bell's telephone are taken away, and on the wood of the instrument there is fixed the end of a small stiff steel spring. The other end of the spring abuts on the surface of the magnetic nucleus surrounded by its coil; to this extremity is soldered a small mass of soft iron, weighing about 10 grms., and upon this mass and in the produced line of the axis of the spring is fixed a light style of bamboo, 10 centimeters in length and terminating in a slender whale-bone pen.

RELATION BETWEEN THE TEMPERATURE OF THE EARTH AND THE DEPTH BELOW THE SURFACE.

By P. VAN DIJK.

THE author draws the following conclusions:—The increase of the geothermic scale proves that the earth is engaged in a continual process of cooling. This increase corresponds to the law of the refrigeration of a spherical body, having a uniform elevated initial temperature. The degree of cooling differs much for different parts of the earth's surface, according to their geographical and thermological position, and exercises an important influence on the vertical distribution of underground heat in any place. The loss of heat which the earth incessantly undergoes from its surface, being infinitely small compared with the quantity stored up within, a large part of the earth's interior must still possess a very high temperature. The real geothermic progression, as accessible to human observation, far from indicating a minimum thickness for the earth's crust, imposes, on the contrary, a very narrow limit on the maximum temperature of the earth's interior. By the abstract application of this progression we should be led to ascribe to the earth's center a heat not exceeding 100°. Actual facts observed, however, cannot be more simply explained than by the reaction of an igneous or fused nucleus, of a crust of considerable thickness, and having little conductibility for heat. The thickness of the earth's crust is very unequal, probably three times greater in the polar regions than in the volcanic regions of the Equator, and in one and the same latitude greater beneath the sea than on dry land. The greatest differences of thickness for one and the same latitude are met with in countries where, with an elevated mean temperature at the surface, the alternation of dry land and deep sea is most frequent. The volcanic character of the Eastern Archipelago agrees with this conclusion. According where the terrestrial crust is thinnest a temperature of 3,000° will be found at the depth of 21 geographical leagues, not more than 1-40th of the earth's radius. In the polar regions it is probably more than four times as thick.

SILK WORMS.

By ALFRED WAILLY, Membre en Lauréat de la Société d' Acclimatation de France.

AS many English entomologists now take an interest in European and exotic lepidoptera, I send you some notes on silk-producing bombyces which have been bred in this country during the year 1878:

SILK-PRODUCING BOMBYCES WITH CLOSED COCOONS.

Attacus Yama-Maï (Japanese oak silkworm).—This species, reared in England for several years with very little success, is in the egg state during the winter. The moths, which pair with difficulty in confinement, lay their eggs in August and September. About a fortnight after the eggs have been deposited, if fertile, they contain a larva which remains in the egg till the end of April or beginning of May (according to temperature) before it makes its appearance. In warmer countries the young larvæ hatch earlier. The eggs of Yama-Maï must be kept in the open air, protected from the rain and the rays of the sun. In case they should hatch before the oak leaves or buds should be sufficiently advanced to feed the young larvæ, small oak trees should be potted and protected from the frost during the winter, but the trees should never be forced in a hot-house. When the young worms have hatched they can at once be placed on the young trees, and they will seldom wander. When larger, the worms must be placed on oak branches (plunged in water) one or two yards long. Small twigs must not be used, still less cut leaves, to feed the worms. Branches should be cut in the evening, never while the sun is shining on them. If these rules be observed, failure in the rearing of the larvæ will be avoided to a great extent.

For the rearing of young larvæ, I have adopted with great success the following plan: I have large bell glasses (with four or five openings on the dome) placed on saucers full of sand, covered with a piece of paper. Small branches are stuck through the paper into the sand, and no water is required to keep the foliage fresh under the glass, which, of course, must not be put in the sun. The larvæ will there thrive till they are large enough to be placed on branches plunged in water. When necessary the glass may be raised so as to give free ventilation; as to the droppings, they can be removed by merely blowing on the paper. If the glasses be large enough, a certain number of the larvæ may be left under them till they form their cocoons, although it is preferable to rear them uncovered when large. When under glass, as no water is required to keep them fresh, the branches may be short, and cut according to the size of the glass, but when plunged in water they must always be long, otherwise the foliage would get watery and cause the death of the larvæ. Yama-Maï worms should not be placed in the open air till June. They want shade, and to be freely watered in hot weather. Ova of this species should always be obtained as early as possible, so that they should pass the winter in the locality where they are to be reared. This plan for rearing the Yama-Maï may be adopted for all the species of silk-producing and other large bombyces.

Attacus Pernyi (Chinese oak silkworm).—This species, a native of North China, is very easy to rear in the open air, and will feed like Yama-Maï, on all species of oak. Being double-brooded, and a second rearing in England being extremely difficult, if not impossible, the cocoons obtained should be kept in a cool place, so as to prevent the moths from emerging in the autumn. In spite of precautions, when the autumn is mild, some of the moths will emerge, but the majority of the cocoons will keep to May of the following season.

The young worms of *A. pernyi* hatch in June or the beginning of July, when there is an abundance of foliage to feed them. Besides this advantage over Yama-Maï, it has another—the great facility with which it is reproduced, the moths always pairing in whatever place they may be. The cocoon is larger than that of Yama-Maï.

Attacus Polyphemus (Telea polyphemus) from North America.—This most valuable insect, which produces a closed cocoon, like the two preceding species, is polyphagous, thriving well on willow, birch, oak nut, chestnut, beech, elm, etc. This species must be considered as single-brooded. It is so in Illinois and Michigan, at least, when the larvæ are reared in the open air.

Several of my correspondents who this year bred *A. polyphemus*, having obtained the moths in the autumn, it must be stated that the cocoons were kept in rooms, which should not be done if they are to be preserved till May of the following year, when the moths begin to make their appearance. It must also be borne in mind that many species of lepidoptera, which are single-brooded in northern countries, may become double-brooded if bred in captivity, or in warmer countries.

A. polyphemus can be reared in the open air in this country. At the end of last July, previous to a journey I made to Paris, I left a few polyphemus larvæ on small trees in my garden, nut, willow, and birch. On my return to London in September, I was much pleased to see fine cocoons on the trees, although the quality of the foliage was not good.

The larvæ of *A. polyphemus* is most magnificent. In its last stage it is covered with forty-eight silver and eight gold metallic spots, the latter being on the first two segments. When the sun shines on the larva, which is of a fine green, with small pink spines, it seems covered with diamonds.

The fine and strong silk of *Attacus Yama-Maï*, *A. pernyi*, and *A. polyphemus* could be seen at the Paris Exhibition. The silk of *Yama-Maï* is light green, *Pernyi* light brown, and *Polyphemus* white. Besides the three species mentioned, there are several others which produce closed cocoons, but as they have not, as yet, been bred in this country, no mention will be made of them.

SILK PRODUCING BOMBYCES WITH OPEN COCOONS.

Of these four species will be mentioned which have been bred in England, France, and Germany, *Attacus cynthia Attacus promethea*, *Attacus cecropia*, *Attacus atlas.* These four species in America go under the generic name of Samia. Cecropia and Promethea also go under the generic name of Hyalophora in America. The larvæ of these four species all have the same form and appearance, and the imagines the same designs on the wings. The moths can all be taken with the hand, and will readily hold to anything, while those of the three species first mentioned, especially Yama-Maï, cannot be held in the hand; the least touch causes them to drop heavily down, and make half a dozen somersaults before they keep quiet. Pernyi, however, is not so wild as Yama-Maï. *Attacus mylitta* (from India), also has the same habits as Yama-Maï. Selene (from India), although belonging to another genus, has also the habit of dropping down when touched, but it will often adhere to the finger.

Attacus cynthia (*Samia cynthia*).—A species acclimatized in France and in the United States of America. Easy to rear in the open air on the ailanthus trees; will feed also, but not so well, on the laburnum, lilac, and cherry. Double brooded. Moths will often emerge in the autumn, especially if the rearing of the larvæ has taken place early. *A. cynthia* is a native of North China; the moths pair as readily as those of *Attacus pernyi*, and emerge about the end of June.

Attacus promethea (*Samia promethea*), from North America.—The cocoon of this species is very similar to that of *Cynthia*, but smaller. The moths do not pair easily; the larvæ are rather difficult to rear. Perhaps the proper food plant has not yet been discovered. The larva in England and on the Continent of Europe has been fed on lilac and cherry. In America, it feeds on the *Laurus sassafras* and *Laurus benzoin*. The male and female moths differ very much in color, the male being of a velvety black, the female brown.

Attacus cecropia (*Samia cecropia*) from North America.—This species is extremely polyphagous, eating almost any kind of foliage: fruit trees, especially plum and apple; also willow (all species), poplar, maple, etc. I received in December, 1877, an extraordinary number of live cocoons of *Cecropia* from America (5,500). It has been bred in 1878 extensively in England, France, Belgium, Germany, Austria, and Portugal. I let go from my garden a large quantity of impregnated females, and also took a quantity to a wood near London. Have some of them established themselves in this country?

Attacus atlas (*Samia atlas, Saturnia atlas*) from India, China, etc.—Food plants: apple, plum, peach, barberry, etc. Of this remarkable species I could only obtain one brood (pairing), the moths having commenced to emerge only a few days before my leaving London for Paris, at the end of July. The ova I obtained (180) all turned out fertile. Most of the larvæ obtained were bred in France, and some in England. A friend of mine in the country succeeded in rearing all the larvæ (excepting a few which had escaped) in a hot house, on the barberry. The larvæ formed their cocoons about a month after their exit from the ova—an extraordinarily short time. I saw the cocoons, which were rather small, the larvæ, very likely, having been forced too much. The result of the rearings of Atlas, in France, which I do not know yet, will be stated in the "Bulletins de la Société d'Acclimatation de Paris." I had Atlas cocoons of two different races; the ova were obtained from the smaller race, which, I was told, came from Bangalore. Early in 1877 I had obtained a few cocoons of a giant race of Atlas, which, with similar cocoons I brought from Paris (empty cocoons), happen to be a race from the Himalaya Mountains. These cocoons did not produce a single moth in the summer of 1877, and some of the pupæ died. But this last summer, in July, I obtained a few moths, far more brilliant in color than the moths obtained from the other cocoons. Two specimens, male and female, are now exhibited, and may be seen in the Insectorium at the Royal Westminster Aquarium, London. The female of this giant race is nearly eleven inches wide from tip to tip of the wings, and is of extreme beauty.

Actias selene (from India).—This year I succeeded in obtaining four pairs of this magnificent species from cocoons sent from India, June 1st, June 21st, July 4th, and July 5th. I obtained over twelve hundred fertile ova; the first female laid three hundred and fifty ova; the second, two hundred and ninety-six; the third and fourth, about three hundred each. So far as I am aware, the larvæ of *Actias selene* was unknown in Europe till I introduced it this year. It has been bred in 1878 in England, France, and Germany. From reports sent by different correspondents I heard that many of the larvæ had died in the last stage. The larvæ which I bred on walnut branches until I left London did remarkably well under one of my large bell-glasses till they were nearly full-grown, none having died, when I had to intrust a friend with the rearing of them. Unfortunately, with twenty-four larvæ, he could only obtain two cocoons, which produced two small male moths in September. *Actias selene* feeds very well on walnut, and also on willow and cherry. This species is essentially a "*polycoltine* race," as we say in French, or "many-brooded." The moths began to emerge on the 28th February, and continued to do so until the 8th of July, when all the moths had ceased to emerge from the cocoons (38 in number). This long lapse of time from the appearance of the first moth, on the 28th February, till the appearance of the last two on the 8th of July, shows the great difficulty I had in obtaining ova of this species; and, if I had not kept a great number of cocoons, in all probability I would have been unable to obtain fertile ova. Besides the species mentioned, I obtained fertile ova of *Saturnia pyri, S. spini, S. carpini;* also *Aglia Eau*, and others; but of these latter I only bred a few *Aglia Eau.*—*Journal Society of Arts.*

A GOOD EDUCATION.

President Eliot's views on education, as expressed in his address at the Smith Female College in Massachusetts last week, are the cause of considerable comment: "I may as well abruptly avow," he said, "as the result of my reading and observation in the matter of education, that I recognize but one mental acquisition as an essential part of the education of a lady or gentleman—namely, an accurate and refined use of the mother tongue. Greek, Latin, French, German, mathematics, natural and physical science, metaphysics, history and æsthetics, are all profitable and delightful, both as training and as acquisitions, to him who studies them with intelligence and love; but not one of them has the least claim to be called an acquisition essential to a liberal education or an essential part of a sound training." This, coming from the President of Harvard College, sounds rather radical.

CARBOLIC ACID FOR WEEDS.

SOME of our exchanges recommend carbolic acid as a destroyer of perennial weeds in lawns. The acid of the shops is diluted and poured from a bottle into a hole in the crown of the plant, made by a pointed iron. We have found a drop or two of strong sulphuric acid sufficient to kill instantly such intruders in lawns as plantains, dandelions, etc. The carbolic acid, largely diluted with water, is recommended for garden walks, applied with a brush or watering pot.—*Country Gentlemen.*